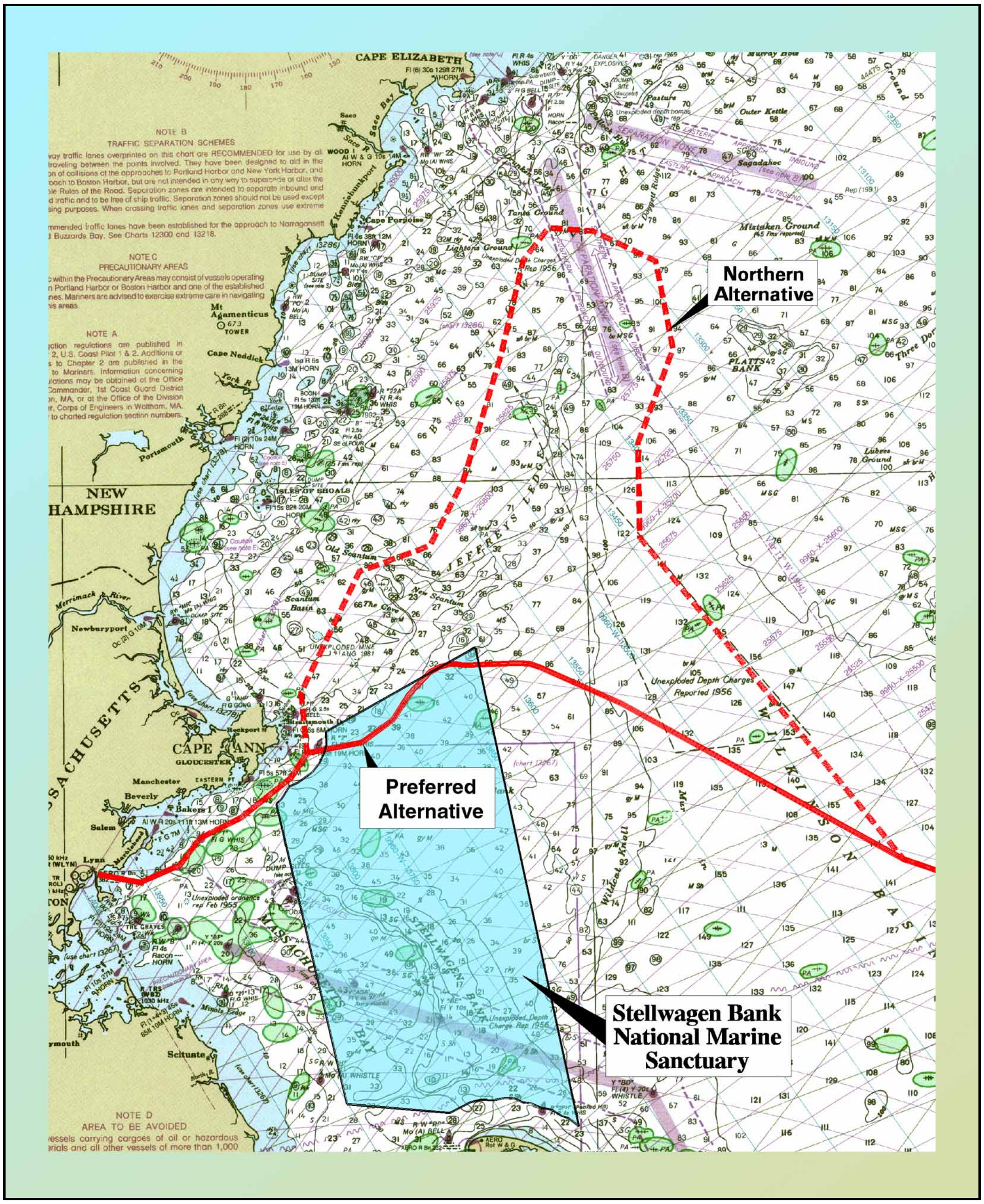
STELLWAGEN BANK NATIONAL MARINE SANCTUARY SUBMARINE CABLE FINAL ENVIRONMENTAL ASSESSMENT



Prepared for:

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Ocean Service
1305 East West Highway
Silver Spring, MD 20910

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ACRONYM LIST

AET	Apparent Effects Threshold
amp	Amplitude
BC	British Colombia
CFR	Code of Federal Regulations
cm	centimeter
ºF	degrees Fahrenheit
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FDA	Food and Drug Administration
FWS	U.S. Fish and Wildlife Service
Hz	Hertz
kg	kilogram
km	kilometer
m	meter
MA	Massachusetts
MATC	maximum acceptable toxicant concentrations
MBDS	Massachusetts Bay Disposal Site
mi	mile
mm	millimeter
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyls
ppt	parts per thousand
ROV	remotely-operated vehicle
SCARAB	submersible craft-assisting repair and burial
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WWTP	wastewater treatment plants

EXECUTIVE SUMMARY

360networks, inc. (formerly Worldwide Fiber) of Vancouver, British Columbia (BC), Canada (the applicant) is proposing the Hibernia Transatlantic Telecommunications Project (Hibernia) to provide high-capacity fiber-optic connections between the United States (U.S.) and Europe. The overall project envisions a communications system that is highly efficient in quality and reliability, designed to minimize potential disruptions of data transmission resulting from network cuts and outages.

The overall Hibernia project would provide the first direct connection between the Republic of Ireland and North America. The increasing demand for global voice and data transmission capability requires the continuing installation of state-of-the-art fiber-optic cables, particularly between densely populated areas of the globe. Existing cable systems across the Atlantic Ocean are or shortly will be at maximum transmission capability, leaving no room for expansion as demand for electronic communications (telephone, facsimile, electronic mail, and the Internet) increases. The proposed Hibernia project would add additional data transmission capability across the Atlantic Ocean.

The Boston, Massachusetts (MA) metropolitan area, being the chief center of commerce in the New England region, was selected as the project terminus in the U.S. To serve that area, portions of Massachusetts Bay closest to metropolitan Boston were evaluated for potential landing sites. A landing site at Lynn Beach, MA is proposed because it is relatively close to Boston and offers favorable shoreline conditions, and because the proposed cable route to the landing site would avoid shipping lanes and dredge channels associated with Boston Harbor.

The portion of the Hibernia project that will lie between Boston and Nova Scotia, Canada includes a segment that is proposed to traverse the Stellwagen Bank National Marine Sanctuary (NMS), which is managed by the National Ocean Service (NOS), of the U.S. National Oceanic and Atmospheric Administration (NOAA). NOAA performed this Environmental Assessment (EA) to analyze the potential environmental effects of this section of the proposed project and to support NOAA's decision-making process.

The applicant's Preferred Alternative is to traverse approximately 19.49 kilometers (km) of the Stellwagen Bank NMS. The applicant also considered, and this EA evaluates, a Northern Alternative that would not cross Stellwagen Bank NMS. Under a third alternative, the No Action Alternative, the proposed submarine cable would not be installed in the subject area. The Preferred Alternative and the Northern Alternative cable routes were identified as alternatives through the application of a series of criteria that address technical feasibility and the minimization of potential environmental effects. Figure ES-1 shows the project area and the two alternative cable routes.

Stellwagen Bank NMS is located approximately 25 nautical miles (mi) east of Boston, at the eastern edge of Massachusetts Bay. The Sanctuary occupies approximately 638 square nautical mi (842 square mi), extending from Cape Ann to Cape Cod, MA. Stellwagen Bank itself is an important geological feature located within the sanctuary. NOAA administers the Stellwagen Bank NMS under the 1972 Marine Protection, Research, and Sanctuaries Act.

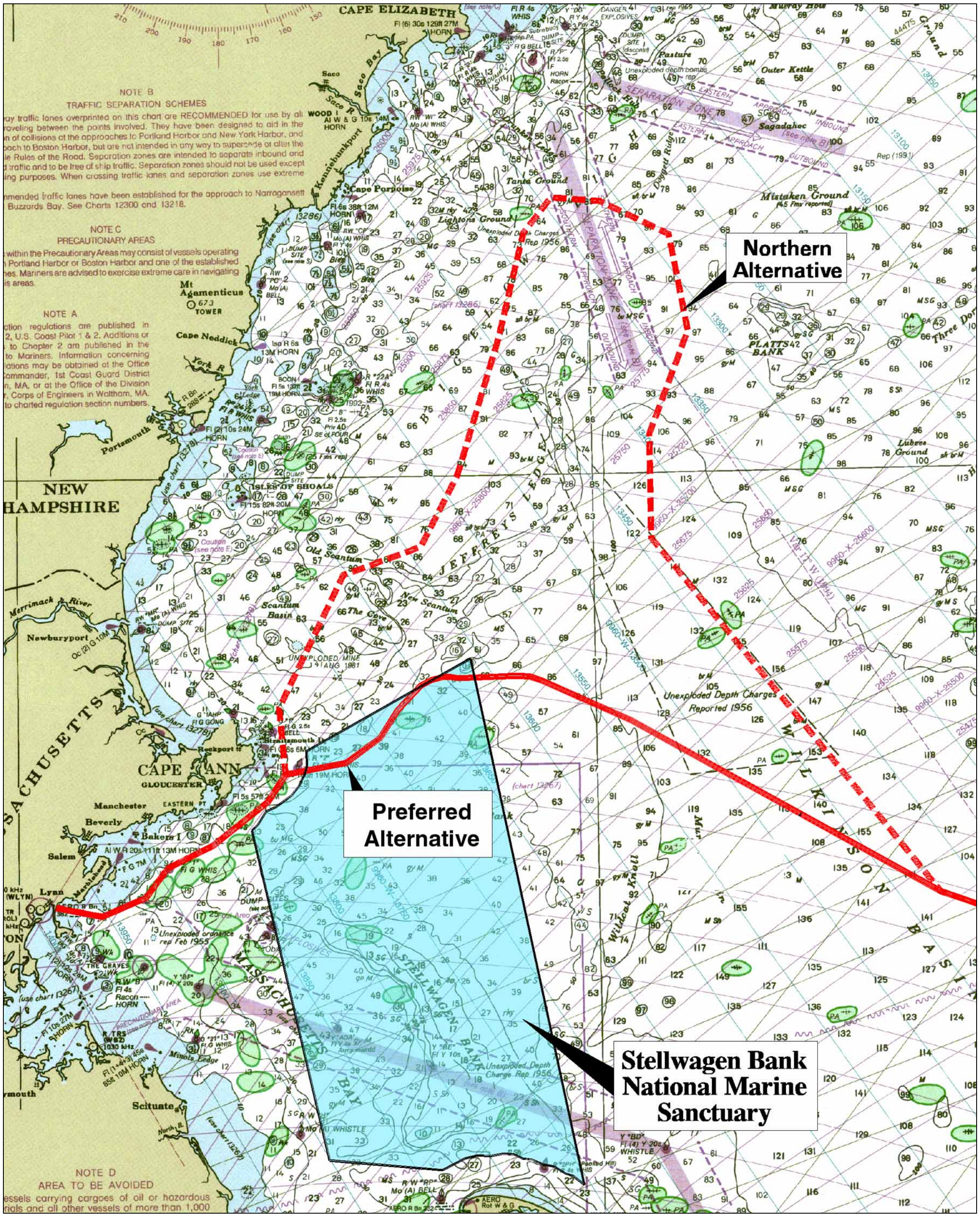
To minimize potential effects on navigation, the fishing industry, other maritime activities, and environmental resources, it is proposed that the undersea cable be installed at a depth of approximately 1.5 meters (m) beneath the sea bed. The proposed installation would occur between the 1,500 m depth contour and the 5 m depth contour, offshore of the proposed cable landing location at Lynn Beach, MA. Burial of the fiber-optic cable also would protect it from potential failures, or faults. To minimize environmental effects, the land portion of the cable route, between Lynn Beach and the cable station, would be located underground and would run primarily along existing roadways.

To install the cable beneath the sea bed, the applicant would use advanced technologies that minimize environmental effects on marine resources. The installation process would use directional drill technology to install cable conduits in the nearshore areas, including Lynn Beach and Nahant Bay, to the 5 m water depth contour. A "sea plow," a cable installation machine that is controlled from a cable ship, would be used to bury the cable in water deeper than 5 meters. This sea plow would be used for all cable installation within the Stellwagen Bank NMS.

In addition to this EA, the U.S. Army Corps of Engineers (USACE) Rivers and Harbors Act Section 10 permit, which is located in Appendix A of this document, addresses potential effects on marine activities and resources. Mitigation measures are activities or procedures designed to minimize or avoid potential environmental effects. Detailed mitigation measures that would be required of the applicant will be listed in the NOAA authorization and Special Use Permit, if issued, and an accompanying mitigation check-list.

This proposal has undergone extensive regulatory review. Permits and approvals from numerous federal, state and local agencies are required before the proposed cable installation is approved. In addition, consultations with the National Marine Fisheries Service (NMFS) of NOAA, and the U.S. Fish and Wildlife Service (FWS) are required under the Marine Mammal Protection Act and Endangered Species Act, respectively. Section 1.3 and Table 1-1 provide details on required permits and consultations.

Figure ES-1: Project Area, Preferred Route, and Northern Alternative Route (Earth Tech 1999)



1.0 PURPOSE AND NEED

360networks, inc. (formerly Worldwide Fiber) of Vancouver, British Columbia (BC) (the applicant) is proposing the Hibernia Transatlantic Telecommunications Project (Hibernia) to provide high-capacity fiber-optic connections between the United States (U.S.) and Europe. The overall project envisions an efficient communications system in terms of quality and reliability, designed to minimize potential data transmission disruptions due to network cuts and outages.

The overall Hibernia project would provide the first direct connection between the Republic of Ireland and North America. The increasing demand for global voice and data transmission capability requires the continuing installation of state-of-the-art fiber-optic cables, particularly between densely populated areas of the globe. Existing cable systems across the Atlantic Ocean are or shortly will be at maximum transmission capability, leaving no room for expansion as demand for electronic communications (phone, facsimile, email, Internet) increases. The proposed Hibernia project would add additional data transmission capability across the Atlantic Ocean.

The Boston, Massachusetts (MA) metropolitan area, being the chief center of commerce in the New England region, was selected as the project terminus in the U.S. In order to serve this area, portions of Massachusetts Bay closest to metropolitan Boston were evaluated for potential landing sites. A landing site at Lynn Beach, MA is proposed because it is relatively close to Boston, has favorable shoreline conditions, and because the proposed cable route to the landing site would avoid shipping lanes and dredge channels associated with Boston Harbor.

The portion of the Hibernia project between Boston, MA and Nova Scotia, Canada includes a segment that is proposed to traverse the Stellwagen Bank National Marine Sanctuary (NMS), which is managed by the National Ocean Service (NOS), of the U.S. National Oceanic and Atmospheric Administration (NOAA). NOAA conducted this Environmental Assessment (EA) to analyze the potential environmental effects of this section of the proposed project, and to support the NOAA decision-making process.

Section 1 of the EA presents a summary of the project's purpose and need, decisions to be made, permits and consultations, and the statutory basis of the EA. Section 2 provides a technical description of the proposed action and alternatives. Section 3 describes the affected environment within the project region. Section 4 presents findings on the environmental consequences of the proposed action and alternatives. Appendices contain additional technical data and consultation letters, and are referenced in the appropriate sections.

1.1 PROJECT PURPOSE AND UNDERLYING NEED

The purpose of the applicant's proposed action is to employ marine cable installation technology to install a buried submarine fiber-optic cable between Boston, MA and Nova Scotia, Canada, using the most direct route feasible. The project would use state-of-the-art cable installation technology to provide for the maximum possible integrity and safety of the installed cable.

The underlying need for the applicant's proposed action is to provide high-speed direct fiber-optic data transmission capabilities between North America and Europe to meet the growing need for commercial data transmission. The increasing demand for global voice and data transmission capability requires the installation of state-of-the-art fiber-optic cables to meet that demand. Existing trans-Atlantic cable systems are or shortly will be at maximum transmission capability, leaving no room for expansion.

Fiber optics is the preferred method of carrying voice, video, and data communications. Its superior information-carrying capacity enables the use of applications that require large amounts of bandwidth. Fiber-optic cable allows for optimization of transmission equipment because it lacks the delay found in satellite connections. Further, unlike satellite communications, fiber-optic cables are insensitive to electromagnetic and/or atmospheric interference and offer a secure link because of their relative immunity to eavesdropping. Finally, cable systems are much less expensive to install and repair than are satellite-based telecommunication systems (Earth Tech 1999).

The applicant has proposed the Hibernia Project to add necessary trans-Atlantic transmission capacity to meet growing demand. As the chief center of commerce for the New England region, the Boston area has been identified as the project terminus in the U.S. (Earth Tech 1999a).

1.2 DECISIONS TO BE MADE

This EA supports NOAA's decision-making process related to the proposed project. Specifically, the decisions to be made by NOAA are:

- Whether to authorize the permit to be issued by the U.S. Army Corps of Engineers (USACE) for the Preferred Alternative
- Whether to issue a special use permit for the Preferred Alternative

1.3 PERMITS AND CONSULTATION REQUIRED

To support NOAA in making the decisions identified above, the applicant has obtained or requested the following federal permits:

- USACE: A permit required under Section 10 of the Rivers and Harbors Act
- NOAA: Authorization of the Section 10 permit issued by the USACE
- NOAA: Special Use Permit, required under the regulations of the Stellwagen Bank NMS for the Preferred Alternative, and issuance of which is contingent on the analysis and conclusions set forth in this EA (15 Code of Federal Regulations [CFR] 922)

Consultations and coordination with the following agencies also are required.

- U.S. Fish and Wildlife Service, in accordance with provisions of Section 7 of the Endangered Species Act of 1973 (16 United States Code [U.S.C.]1531)
- National Marine Fisheries Service (NMFS) of NOAA, in accordance with provisions of the Marine Mammal Protection Act of 1972 (16 U.S.C. 1361)
- NMFS of NOAA, in accordance with provisions of the Magnuson-Steven Fishery Conservation and Management Act, 1996 amendments
- Commonwealth of Massachusetts Historic Commission, Bureau of Underwater Archeological Resources, in accordance with provisions of Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800)

Table 1-1 presents other state and local permits applied for or obtained and consultations and coordination completed or underway. Appendix A of this document contains copies of correspondence related to consultation and coordination with key agencies at the federal, state, and local level.

1.4 STATUTORY BASIS

This EA was conducted in accordance with requirements of the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), regulations of the Council on Environmental Quality (40 CFR 1500-1508), and NOAA Administrative Order (NAO) 216-6. NOAA authorization and special use permit procedures for activities proposed within Stellwagen Bank NMS are set forth in 15 CFR 922, subparts E and N.

Subpart N, section 922.142 lists activities that are prohibited within the Stellwagen Bank NMS, unless a permit or other authorization has been obtained. Subpart E, section 922.49 states: "*A person may conduct an activity prohibited if such activity is specifically authorized by any valid Federal, State, or local lease, permit, license, approval, or other authorization issued after the effective date of Sanctuary designation…*" if certain provisions are met. Those provisions are:

- Formal notification by the applicant to the director of the Office of Ocean and Coastal Resource Management, NOAA
- Notification of the applicant by NOAA that NOAA has no objections to issuance of the authorization
- Submittal of additional information, if so requested by the director

NMFS notified the applicant, on March 3, 2000, that NMFS had no objections to issuance of a USACE permit, provided that the applicant obtain a NOAA authorization that is appropriately conditioned, and conduct a required NEPA analysis. Appendix A contains a copy of this correspondence.

Accordingly, the purposes of this EA are to:

- Determine whether the proposed action might have significant effects on the environment, and whether a more detailed study of those effects therefore would be warranted
- Identify and describe in detail potential mitigation measures that would be required of the applicant
- Review alternative courses of action

Table 1-1
Required State Permits and Agency Consultations

Permit	Issuing Agency	Permit Submittal Date	Permit Receipt Date	Comments
ENF Certificate	EOEA, MEPA Unit	9/99 – (10/9/99–date of notice in Monitor)	10/12/99	Secretary's certificate received; no environmental impact report is required.
401 Water Quality Certificate	Massachusetts Department of Environmental Protection	NA	NA	DEP has determined that the project does not require 401 water quality certification (correspondence dated November 18, 1999)
Statement of Consistency w/Ocean Sanctuaries Act	Massachusetts DEM	NA	11/1/99	Should be combined with Chapter 91 process; no official permit is required from DEM.
Federal Consistency Determination (based on Federal Consistency Certificate)	Massachusetts CZM	1/6/99	3/6/99	Other state permits must be obtained before issuance. Review by CZM will be combined with Chapter 91 process.
Chapter 91 License	Massachusetts DEP	10/8/99	2/1/00	401 Water Quality Certificate, NOI, and ENF certificate must be submitted with Chapter 91 before issuance of the license. The project is located within commonwealth tidelands, and therefore, the Governor's signature is required.
Construction Permit	MDC	12/3/99	1/3/99	The permit is required for installation of cable within the MDC park west of the seawall and within the Lynn right-of-way (ROW)
MESA Consultation	Division of Fish and Wildlife, Natural Heritage and Endangered Species Program	NA	NA	The Natural Heritage and Endangered Species Program consultation letter was received on October 1, 1999.

Notes:

CZM Coastal Zone Management
DEM Department of Environmental Management
DEP Department of Environmental Protection
ENF Environmental Notification Form
EOEA Executive Office Environmental Affairs
MESA Massachusetts Endangered Species Act
MDC Massachusetts Department of Construction
MEPA Massachusetts Environmental Policy Act
NA Not Applicable
NOI Notice of Intent

Table 1-2
Required Local Permits and Agency Consultations

Permit	Issuing Agency	Average Time to Obtain Permit	Permit Submittal Date	Permit Receipt Date	Comments
Order of Conditions (based on NOI)	Lynn Conservation Commission	1 month	10/18/99	12/1/99	Order of Conditions has been received
	Rockport Conservation Commission	1 month	10/5/99	10/31/99	Order of Conditions has been received
	Gloucester Conservation Commission	1 month	10/5/99	10/31/99	Order of Conditions has been received
	Manchester Conservation Commission	1 month	10/11/99	11/11/99	Order of Conditions has been received
	Beverly Conservation Commission	1 month	10/11/99	11/11/99	Order of Conditions has been received
	Salem Conservation Commission	1 month	10/12/99	11/12/99	Order of Conditions has been received
	Marblehead Conservation Commission	1 month	10/12/99	11/12/99	Order of Conditions has been received
	Swampscott Conservation Commission	1 month	10/5/99	11/5/99	Order of Conditions has been received
Road Opening Permit	Lynn Department of Public Works	Approximately 1 week	12/1/99	12/8/99	Coordination with the Lynn Police Department

NOI Notice of Intent

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This section of the EA provides a detailed description of the Preferred Alternative (the proposed route through Stellwagen Bank NMS), the Northern Alternative route, and the No Action Alternative.

2.1 ALTERNATIVE SELECTION CRITERIA

The applicant and NOAA applied the following selection criteria to determine the range of reasonable alternative routes that meet the purpose of the project and fulfill identified needs.

- **Potential cable routes must be economically viable.** To meet the project's stated purpose, installation of cable along the route must not be prohibitively expensive or time-consuming.

- **Potential cable routes must be technically feasible.** Technical feasibility refers to the ability to fully exploit sea plow technology to meet designated fault tolerances. High confidence that potential threats to the integrity of the cable are minimized must be ensured.

- **Cable must be buried along the entire length of the segment within the Stellwagen Bank NMS, to the extent that doing so proves technically feasible.** If the cable wire were unburied, that circumstance would increase potential hazards and effects on commercial fisheries, benthic communities, and potentially, marine mammals. Damage to fishing gear is also more likely when a cable is unburied. In turn, increased rates of cable failure could be expected.

- **Cable routes should avoid traversing rock, to the extent that is technically feasible.** Traversing rock would require blasting, which is not under consideration, or laying the cable on the sea bed. For that reason, both alternative routes are designed to minimize or avoid rock crossings.

- **Routes should avoid sensitive environmental resource areas, insofar as possible.** Both alternative routes are designed to avoid sensitive environmental resources (for example, valuable benthic communities) to the greatest extent possible.

- **Potential routes should avoid, when possible, dredge spoil sites, abandoned cables (if any), military disposal sites, and other disturbed areas.** Burial installation of cable through any such sites could disturb concentrations of hazardous or explosive materials and contribute to contamination of both the water column and sediment.

2.2 ALTERNATIVES CONSIDERED

Through an application of the selection criteria discussed above, the following alternatives are considered in this EA.

- **Preferred Alterative:** A cable route that traverses approximately 19.49 km of Stellwagen Bank NMS

- **Northern Alternative:** A route that turns to the north before reaching Stellwagen Bank NMS, circumventing the sanctuary

- **No Action Alternative:** No cable would be installed

2.2.1 Preferred Alternative

The applicant's Preferred Alternative is for a section of the overall Hibernia Project to traverse the Stellwagen Bank NMS. From Halifax, Nova Scotia, Canada, the proposed cable route enters U.S. territorial waters at the Hague Line, crosses Wilkinson Basin, and enters the Stellwagen Bank NMS near the northeast corner of the sanctuary. The cable route then traverses approximately 19.49 km of the sanctuary, along its northern boundary, and leaves the sanctuary near its northwest corner, off Rockport, MA (see Figure ES-1). From that point, the cable continues in a westerly direction to the cable-landing site at Lynn Beach, MA. Lynn Beach was identified as the landing site because of its proximity to Boston and its favorable shoreline conditions, and because the cable route to that landing site would avoid shipping lanes and dredge channels associated with Boston Harbor. The preferred cable route is intended to maximize use of state-of-the-art cable installation technology to maximize the integrity and safety of the installed cable, while minimizing the potential environmental effects of the installed cable.

Cable Route

The length of the Preferred Alternative route from the point at which it diverges to the point at which it rejoins the Northern Alternative would be approximately 115.3 km (see Figure ES-1) (Seafloor Surveys International, Inc. 1999). This would include approximately 19.49 km of the Stellwagen Bank NMS. The entire cable segment within Stellwagen Bank NMS would be buried, thereby reducing potential effects on fishing vessels and marine mammals. The applicant believes that the Preferred Alternative route is the most economically efficient routing. The Preferred Alternative route has been pre-surveyed by side-scan sonar and subbottom profiling to identify sediment types along the route and to confirm the absence of any conditions or obstacles that might affect burial of the cable. In addition, core samples were taken to confirm the sea bed sediment types present (360networks, inc. 2000a). The route has been designed to avoid potential areas of environmental sensitivity, landslide vulnerability, and areas of high importance for commercial fisheries.

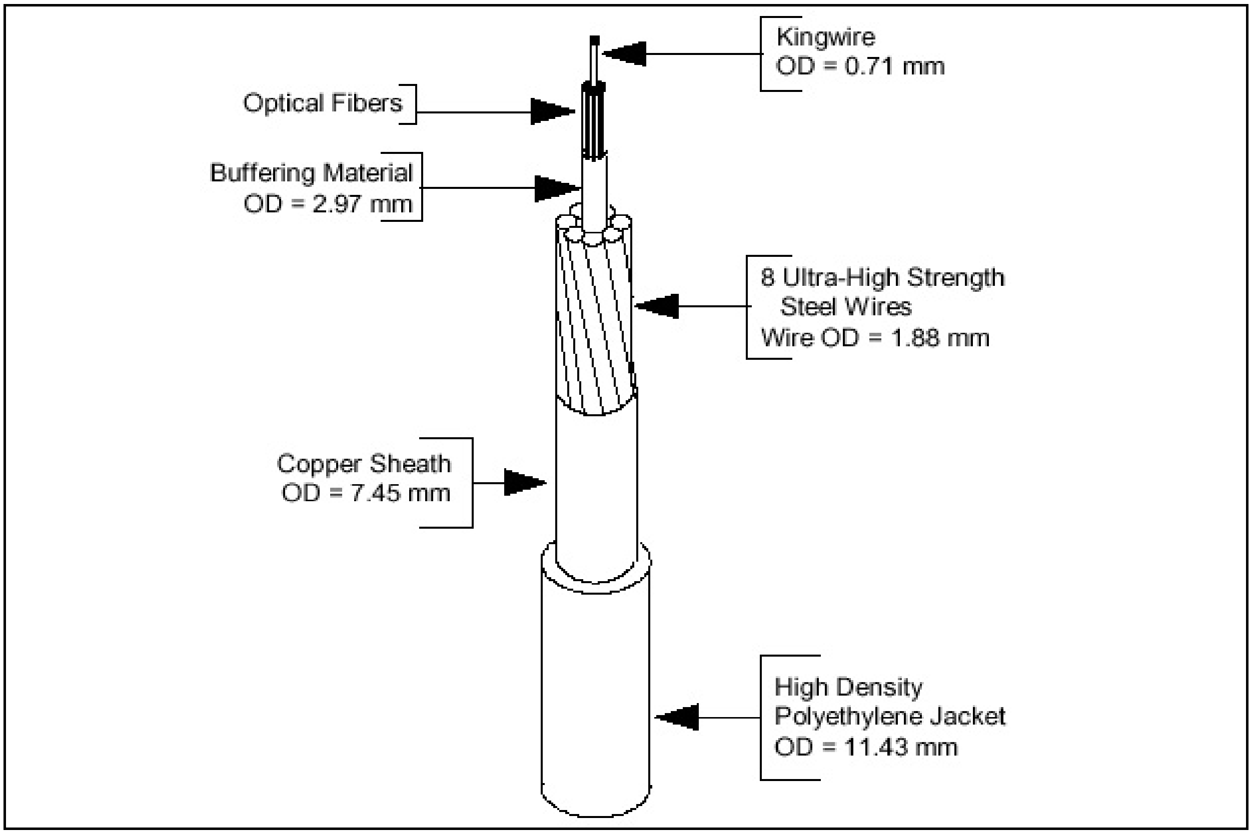
Cable Characteristics

The undersea fiber-optic cable would consist of a 2-inch-diameter cable that has a core of eight glass fibers and an external protective coating of steel cables. An inner polyethylene sheathing surrounds the fibers; an outer layer of armor wires and cotton and pine tar protects against ingress of water (Earth Tech 1999). The cable does not contain any liquids or other material that would leak out of the protective coating in the event of a break. Figure 2-1 displays a cross-section of the proposed cable and sheathing.

Fiber-optic cable networks require the installation of repeaters to maintain the strength and integrity of transmission. A typical repeater consists of a thickening of the cable, one foot in diameter and five feet in length, inside of which electrical components are located. Repeaters are installed at intervals of approximately 50 km along the entire length of the project.

The applicant's surveys indicate that the closest repeater to the west of the Stellwagen Bank NMS would be 17.78 km from the sanctuary and that no repeaters would be installed within the 19.49 km span through the sanctuary (360networks, inc. 2000a). Appendix B presents additional technical specifications for the proposed cable.

Figure 2-1: Cable Cross-Section (360networks, inc. 2000a)



Cable Installation

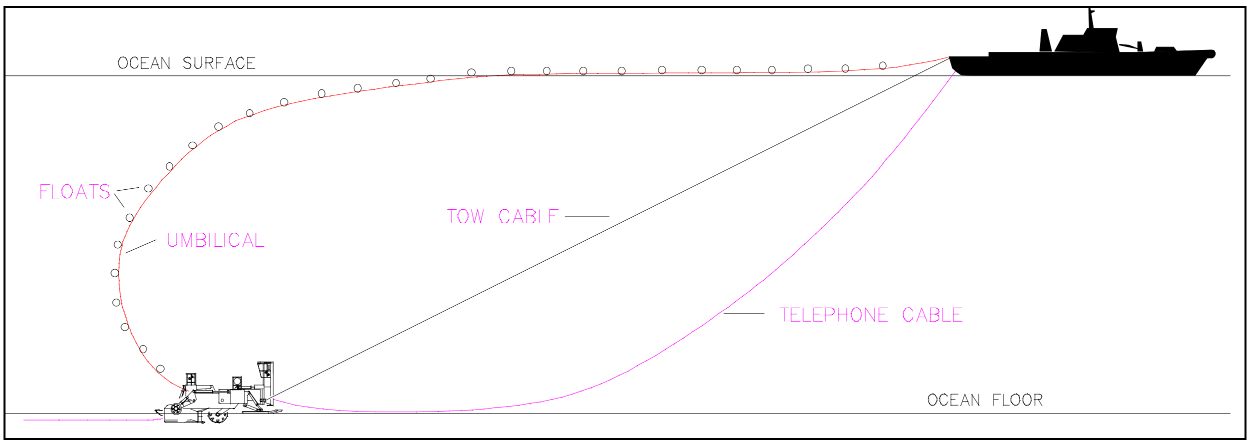
Before the cable is installed, a grapnel drag would be performed along the cable route to determine the presence of any unknown (abandoned) cables or any fishing gear or other debris. The depth of the prongs on the grapnel is approximately 40 centimeters (cm). The width of the grapnel spear (the portion that penetrates the sea bed) is 6 inches (in) across. Any obstacles encountered would be severed after appropriate confirmation is made that the cable, rope, wire, or other obstruction has been abandoned. The grapnel drag would be performed along the approved cable route only. A database of known cables in the world (including known abandoned cables) will be used to identify all existing cables along the route. That database is maintained to identify cables along a prospective cable route and is updated regularly with information from parties involved in the submarine cable industry. The route survey also is able to detect cables along the route.

Two 6-inch steel conduits would be installed beneath the nearshore areas of Nahant Bay to the 5 m water depth. Hibernia initially would occupy one of those conduits, and the second conduit would accommodate a future, as yet unidentified, project. The directional drill from shore would allow the cable to be installed within the conduit from the landing site to the 5 m water depth without disturbance to the sea bed. In offshore areas, the cable would be buried approximately 1.5 m beneath the ocean bottom from the end of the conduit to the 1,500 m depth level, which occurs at the continental shelf in international waters. Cable installation in depths of more than 1,500 m would be accomplished by laying the cable unburied along the ocean bottom.

Although the cable installation proceeds at a slow rate, the time required for installation of the cable in the sanctuary would be expected to be minimal. If the cable ship moves at approximately 0.5 to 1.0 nautical mile (knot) (a knot is slightly more than 1 mile per hour) and the proposed length of the route in the sanctuary is approximately 19.49 km, it is expected that the cable could be installed through the sanctuary in less than two days. Further, cable installation activities would be coordinated with all interested parties to ensure minimal effects during the installation phase (Earth Tech 1999).

To minimize potential effects to navigation, the fishing industry, other maritime activities, and environmental resources, the undersea cable would be installed approximately 1.5 m beneath the sea bed. To install the cable beneath the sea bed, the applicant would use the "Sea Plow VII," an unmanned towed vehicle that is controlled from a cable ship. The Sea Plow VII operates on the ocean floor to bury telephone cables, small flexible pipe, and associated line accessories, such as repeaters and splice boxes, to depths of as much as 1,500 m. Figure 2-2 illustrates a typical burial configuration that uses the Sea Plow VII burial vehicle towed by a cable ship.

Figure 2-2: Sea Plow VII Burial Plowing Configuration (Earth Tech 1999)



State-of-the-art navigation technology enables the plow to follow the cable route to an extremely high degree of accuracy. The plow process would displace a shallow wedge of the sea bed temporarily (approximately 1.0 m wide by 1.5 m deep) and install the cable within the trench. The displaced soil then would be returned to its original location. The minimal amount of soil disturbance required for installation and the immediate restoration of the disturbed area would limit effects on the marine environment. The process does not involve activities typically associated with dredging, such as suspension, side-casting, or permanent removal of sediment (Earth Tech 1999).

Sea Plow VII is towed with a steel tow wire by the support ship from which it is launched. A traction winch is used to control payout and retrieval, as well as tension on the tow wire. The Sea Plow VII vehicle is controlled from a console located in the control van on deck, to which the vehicle is connected by a fiber-optic umbilical cable. Launching is accomplished by use of a hydraulically operated A-frame on the stern of the support ship. Payout and retrieval of the umbilical cable is accomplished by use of a separate dedicated winch. Cable payout is controlled by a linear cable engine or a drum cable engine.

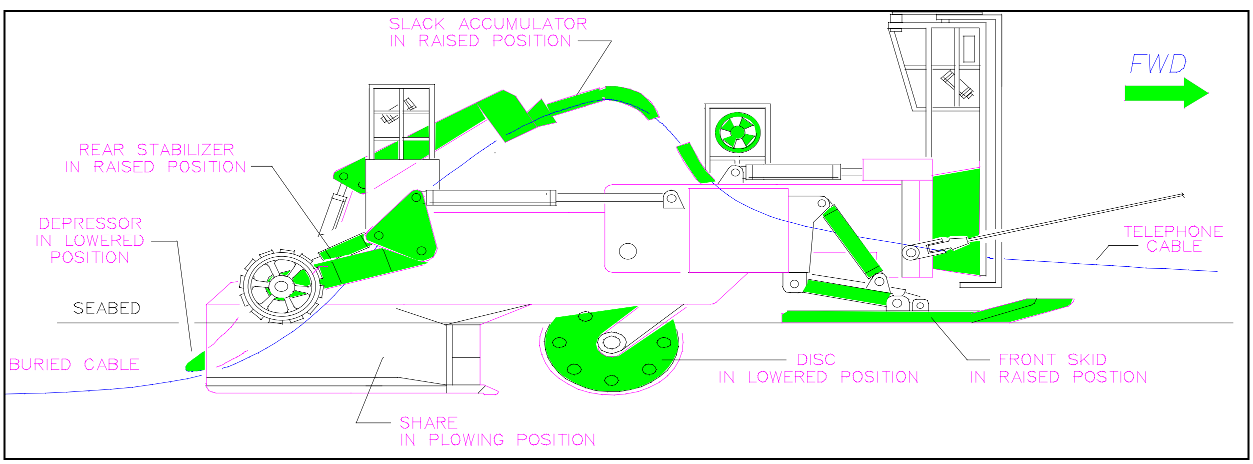
Sea Plow VII is equipped with hydraulically adjusted front skids, adjustable rear wheels and stabilizers, a variable-depth plowshare, an adjustable cutting disc, a steering mechanism, an adjustable slack accumulator, as many as three monochrome video surveillance cameras with lighting, obstacle avoidance sonar, and other electronic sensors and controls. Appendix C contains additional technical detail on the Sea Plow VII.

The total width of the sea plow is 4.6 m including skids and rear stabilizers, which have wheels attached at their ends. The ground bearing of the plow on the sea bed is approximately 400 pounds per square inch (lb/in^2). This is the static load of the plow as it rests on the sea bed based on its submerged weight. This does not include the tow cable tension, which would induce an upward lift on the plow. It also does not consider that uplift of the plow tip or plow share uplift that is generated during plowing operations. The plow is designed such that during plowing, the weight of the plow rests on the plow share to achieve maximum penetration. Thus, the bearing on the sea bed from the plow during installation operations is significantly decreased by these operational factors (360networks, inc. 2000c).

The skids and rear wheels prevent significant disturbance of the sediment and the settlement of the plow into the sediment during the cable laying process. Thus, the net impact of the cable installation process by direct plow technique proposed is the temporary dislocation of a wedge of soil 1.0 m wide at the sea bed surface. Total area of disturbance within the Stellwagen Bank NMS is estimated at 1.0 m wide by 19.5 km long or approximately 4.8 acres of disturbance.

At the beginning of burial operations, the cable is loaded into the sea plow while the sea plow is onboard the cable ship. The sea plow then is lowered to the ocean bottom (with the cable already inside the plow). That operation causes a small section of cable, where the sea plow initiates burial, to be exposed during plow operations. After the cable has been installed, the exposed areas are buried by a remotely-operated vehicle (ROV), such as a submersible craft-assisting repair and burial (SCARAB) vehicle. At the completion of the cable burial operations, the sea plow is retrieved and replaced onboard the cable ship. Figure 2-3 shows some key details in a starboard view of the Sea Plow VII in cable burial mode.

Figure 2-3: Sea Plow VII in Cable Burial Mode (Earth Tech 1999)



To ensure safety during the cable-laying process, a checklist is reviewed, and a project-specific plan is developed. The various operational phases are reviewed, and the possible risks posed by intrusion by pleasure boats and fishing vessels and other commercial traffic are determined. Appropriate security requirements for identifying and warning against or preventing such intrusions are identified. Such security requirements may include notice to mariners, patrol picket boats, aircraft fly-overs, and the placement of warning or marker buoys.

The cable-laying operations would be conducted 24 hours a day. The officers and crew of the cable ship routinely would take actions appropriate to the prevailing circumstances and conditions to conduct safe operations at all times (day or night) and in all kinds of weather. Cable operations would cease if a safe operation could not be achieved. Therefore, no increased risks resulting from nighttime operations are anticipated.

Installation of the cable could be temporarily halted when sea conditions are unfavorable, without severing the cable. However, modern cable ships can hold position under the most extreme weather conditions so that abandonment and retrieval of cable does not become necessary (360networks, inc. 2000a).

Operation and Maintenance

Once the cable has been placed in service, operation of the cable would not likely require any marine activity, by ships, submersibles, or divers. Maintenance of the cable, other than that necessary to repair direct damage to it, would not require marine activities.

The assumption of fault rates by the applicant's maintenance providers for the entire 12,124 km Hibernia Project is from 1.58 to 2.58 faults per year. Use of the high-end figure yields an expected number of approximately 0.005 faults along the cable segment that lies within the Stellwagen Bank NMS, or one fault every 200 years (360networks, inc. 2000a). The primary threat to submarine cables is bottom fishing; the fault rate considers both buried and unburied cables, although historically the majority of faults affect unburied cable. Therefore, the applicant considers the quoted fault rate for the Stellwagen Bank NMS to be a conservative estimate (360networks, inc. 2000b). Appendix D provides excerpts from a technical paper that describes in detail threats to submarine cables.

In the unlikely event of a fault in the system (damage to the cable) within Stellwagen Bank NMS, a cable repair ship would proceed to the repair site, and a low-frequency tone would be applied to the cable to assist in locating it. The ship then would deploy a remotely operated vehicle (ROV), such as the SCARAB. The SCARAB is used to unbury the cable, assist in retrieving the cable from the ocean floor, and to rebury the cable after the repair has been completed. During repair operations, the SCARAB is tethered by an umbilical cable to a vessel, upon which the supporting equipment is mounted. Such support equipment include an articulating crane, used for launch and recovery; a control console enclosed in a control van; portable power generators and hydraulic power units; a maintenance van that contains maintenance tools and spare parts; and a cable storage winch for the umbilical cable (Earth Tech 1999).

The amount of cable that would need to be unburied in the event of a repair is approximately three times the water depth in the vicinity of the repair. During the process of unburying the cable, the ROV would typically displace approximately 3 inches of sea bed around the cable. After the cable is unburied, it would be pulled up to the surface using the cable handling equipment on the cable ship. In the event of a cable break, both ends would be brought to the surface. The scrap-tag end would be recovered by the cable ship and the actual fault would be cut off and labeled. The cut ends would be tested, and when the tests have been completed and a fault-free cable re-established, the cable ends would be sealed and buoyed off for later recovery. The amount of cable to be removed from the line during a repair would be calculated with an added 1 km for contingencies. This approximately 1 km loop of cable would be reburied upon repair completion. The repair cable would be spliced to one of the existing cable ends. When the initial splice has been completed and tested, the repair cable would be paid out toward the other cable-end recovery buoy, which would be recovered and brought to the splicing area on board. The repair cable then would be cut to length and spliced to the existing cable. Upon satisfactory completion of tests, the final splice would be lowered to the sea bed and cut away. The ROV would then bury the repaired cable (360networks, inc. 2000d).

Replacement of a damaged repeater would be accomplished as described above. The existing cable would be cut, and both ends brought to the surface. A new repeater and repair cable would be spliced to one of the existing ends and lowered to the sea bed. The repair cable then would be buried by an ROV such as the SCARAB. As stated earlier, no repeaters would be located within the Stellwagen Bank NMS (360networks, inc. 2000a and Earth Tech 1999).

Cable Life-Cycle

The life expectancy of the cable is 25 years. Conventionally, cables are abandoned and left on the sea bed at the end of their lifespan. Because the cable segment crossing Stellwagen Bank NMS would be buried, there is little chance that it would become uncovered during its lifespan. Leaving the cable in place would avoid any environmental effects associated with its removal. Possible future plans for the cable may include donation of the cable to the scientific community to be used for monitoring of the sea bed (Earth Tech 1999). An alternative approach would be to remove the cable at the end of its estimated life expectancy. Doing so would entail effects on recolonized benthic communities along the cable route.

2.2.2 Northern Alternative

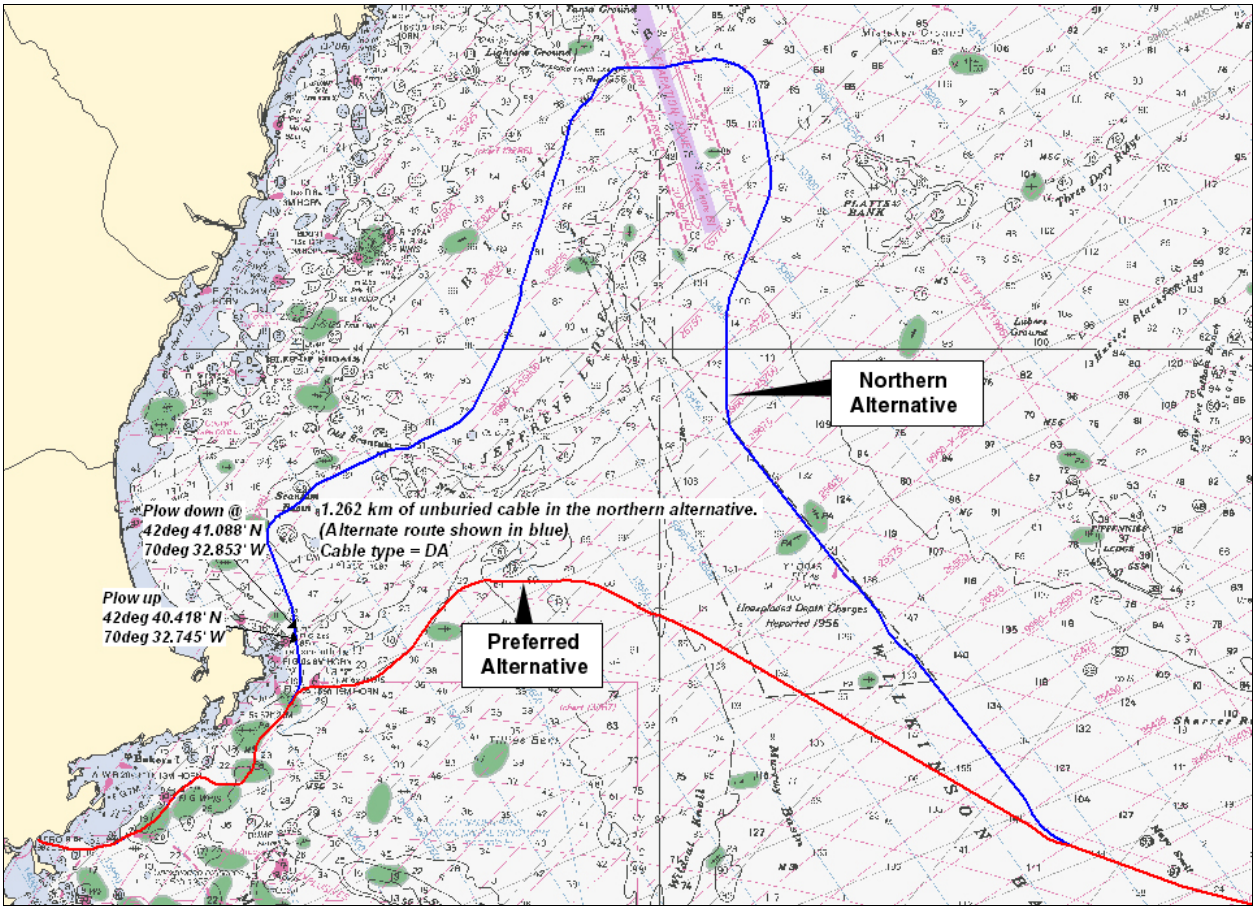
For the Northern Alternative cable route, installation and operations and maintenance activities would be expected to be almost identical to those for the Preferred Alternative. Accordingly, this section discusses only those activities or materials that differ from those discussed in Section 2.2.1.

Cable Route

The Northern Alternative has been identified as an alternative cable route that would avoid the Stellwagen Bank NMS. The alternative deviates from the Preferred Alternative at Wilkinson Basin, well to the east of the sanctuary. From that point, the route proceeds north-northeast avoiding the sanctuary and Jeffrey's Ledge, a geologic formation with features that include sands and gravels, rocks, rock ledges, and steep slopes (Drew 1999, cited in Earth Tech 1999). North of Jeffrey's Ledge the route turns to the west, then to the south-southwest, staying to the west of the ledge, passing between Old Scantum and New Scantum Banks and rejoining the Preferred Alternative route approximately 2 mi off the coast of Cape Ann, MA (Earth Tech 1999). The length of the Northern Alternative route from the point at which it diverges to the point at which it rejoins the Preferred Alternative would be approximately 219.9 km (see Figure ES-1) (Seafloor Surveys International, Inc. 1999).

Detailed ocean surveys of the Northern Alternative have confirmed that along portions of the route, burial of the cable is not possible because of geologic conditions. Figure 2-4 is a map of the Northern Alternative cable route, indicating segments that would be unburied (360networks, inc. 2000c). Three main areas of concern indicate that full burial of the cable would not be possible. The first area of concern is located at the west edge of the southern margin of Jeffrey's Ledge. A granite headland outcrop continues seaward across the area surveyed. Data from side-scan sonar and subbottom profiling indicate that the granite continues to the east. The existence of only a limited, discontinuous, thin veneer of sediments would force surface-laying of the cable over that bedrock area. Bedrock continues until it reaches Jeffrey's Ledge. A 6.5 km perpendicular development line was run northeast across the survey area in an attempt to define the extent of the bedrock. The effort proved unsuccessful, since there were no breaks in the bedrock that might allow burial of a cable.

Figure 2-4: Northern Alternative Cable Route (360networks, inc. 2000a)



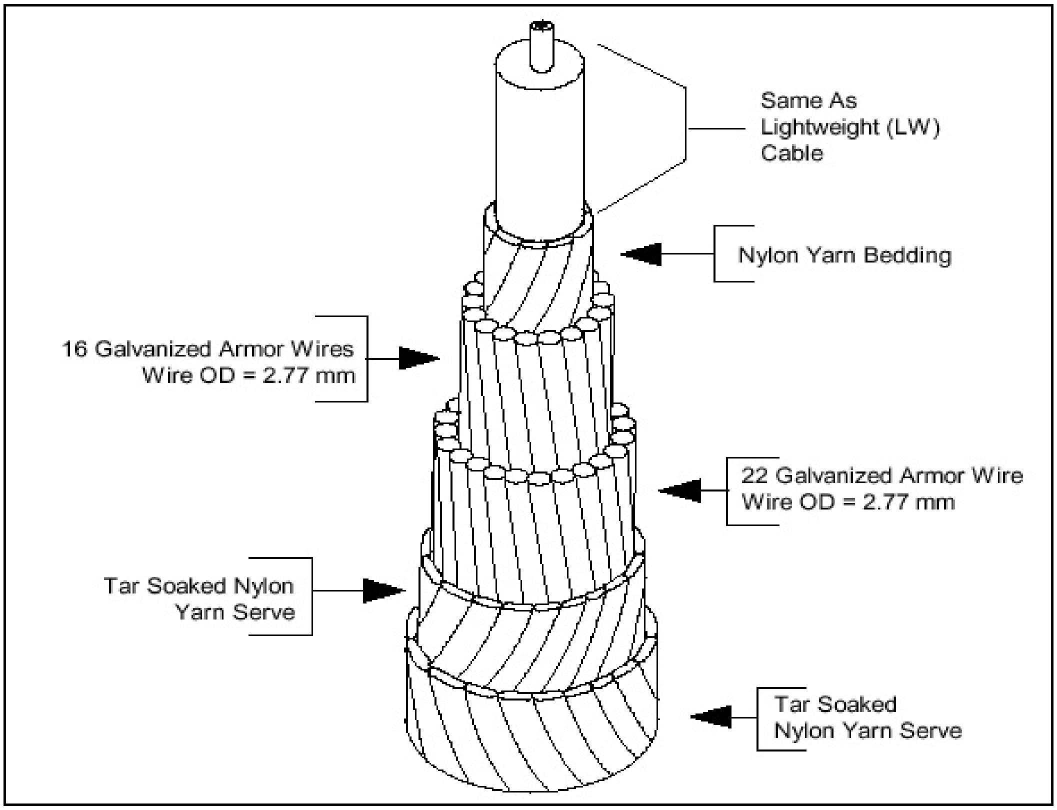
Farther north along the route, a small crevasse was surveyed. The area is bounded on both sides by large outcrops of granite bedrock. The area was surveyed extensively in search of a more benign route. Although a 3 km swath was conducted, no such route was found. Another concern related to the area is the speed of the currents that travel through the crevasse. The current could cause cable strumming or removal of sediment from the area that could jeopardize the integrity of the cable.

The northern portion of Jeffrey's Ledge is composed of large areas of granite outcrops and sharp granite ridges. To avoid these outcrops, a new survey route was identified 5 km south of the original route, but still north of Jeffrey's Ledge. The new route did prove more hospitable, with less frequent outcrops of granite. The area remains a concern related to installation because of the proximity of the cable route to the outcrops. Therefore, selection of the Northern Alternative would require that certain portions of the cable be installed along the seafloor (approximately 1.262 km), rather than buried (Earth Tech 1999).

Cable Characteristics

Should the Northern Alternative route be chosen, the technical specifications for the proposed cable would differ slightly than those for the Preferred Alternative. If a fiber-optic cable is to be laid on the sea floor without burial, additional armoring of the cable is necessary to lessen the potential for accidental breaks in the cable that could occur. Figure 2-5 shows the more heavily armored cable that would be used if the Northern Alternative cable route were selected. The cable for the Northern Alternative contains extra layering or armoring to protect against possible damage along the segment that would not be buried.

Figure 2-5: Armored Cable Cross-Section (360networks, inc. 2000a)



Cable Installation

For the Northern Alternative, approximately 104.6 km of additional cable would be required, compared with the Preferred Alternative route (Seafloor Surveys International, Inc. 1999). Other than the greater length of cable to be installed (and therefore more sea bed area to be affected), the installation procedures would be identical to those described for the Preferred Alternative, except as noted below. Detailed marine surveys indicate that burial of the cable would not be possible along certain portions of the Northern Alternative route because it would be necessary to cross rock. It is anticipated that approximately 1.262 km of the cable would be unburied because of unfavorable sea bed conditions (360networks, inc. 2000c).

For installation of unburied cable, the cable ship would follow a charted course for the project, paying out cable as it proceeds. As the cable is paid out, sufficient slack is maintained to ensure that the cable is placed along the ocean floor with no tension and no suspensions. The armored cable is allowed to sink at a controlled rate into its desired position. Installation of unburied armored cable generally proceeds at a rate of 2 knots.

Operation and Maintenance

Based on studies of other cable systems, those with no burial or shallow burial have higher rates of breaks and subsequent repairs than buried cable systems. However, operations and maintenance activities (and the likelihood of the need for maintenance) would be essentially the same as those described for the Preferred Alternative route because of the very short segment that would be unburied.

Location of the cable would be marked on marine charts, and unburied segments would be noted (360networks, inc. 2000b).

Cable Life-Cycle

For the Northern Alternative route, the life-cycle of the cable would be identical to that described for the Preferred Alternative route.

2.2.3 No Action Alternative

Under the No Action Alternative, the proposed undersea fiber-optic cable would not be installed. No operations and maintenance activities would occur. This alternative would not fulfill the purpose of the project or meet the identified needs for high-speed data transmission. It therefore would be necessary to consider alternative methods of meeting data transmission requirements.

2.2.4 Alternatives Considered But Not Carried Forward for Analysis

The applicant evaluated a number of alternative approaches and cable routes that either did not fulfill the purpose of the project or did not meet the criteria set forth in Section 2.1. The major factors that affected the acceptability of those options were potentially adverse environmental effects, unstable shorelines, and problems related to technical feasibility.

All-Land-Based Route

An entirely land-based route for the length of the cable between the Boston area and Nova Scotia was evaluated. An all-land-based route was determined to be substantially more expensive, more prone to failure, and likely a cause of greater environmental effects than a submarine cable. Some portions of a land-based route might require installation on poles, an approach that is far less reliable than a submarine installation, because of vulnerability to weather conditions. Selection of an entirely underground route would require new rights-of-way and considerable temporary ground disturbance. For those reasons, the option was ruled out as an alternative for consideration in this EA (Earth Tech 2000a).

Southern Avoidance Route

The applicant evaluated a southern alternative route that would bypass the Stellwagen Bank NMS. The route would allow for only 3.7 mi between the Cape Cod shoreline and the southern border of Stellwagen Bank NMS. Because of proximity to potentially unstable banks, the route was considered to increase risks to the integrity of the cable as a result of potential sediment slumps. Environmental considerations also made the option unacceptable. The southern alternative route would transit critical habitat for the endangered northern right whale and would entail entanglement risks during installation. The southern alternative route also would require a landing site other than the Lynn Beach site and would pass through key lobster fisheries. For those reasons, the option did not meet the criteria of minimizing environmental impacts and minimizing threats to the integrity of the cable (Earth Tech 2000a).

Northern Avoidance Route

The applicant evaluated the possibility of routing the cable just north of the boundary of the Stellwagen Bank NMS. Extensive surveys performed in that area determined that the sea bed in the area is unsuitable for installation of cable because of the geologic feature known as Jeffrey's Ledge. Prevalent rock outcroppings in the area would put the cable at high risk of damage from strain. Burial of the cable would not be possible in a large portion of this route, and stable installation along the sea bed also is unlikely because of the geologic features of the area. In addition, the area is fished and trawled more heavily than the routes considered for the Preferred Alternative or that for the Northern Alternative that avoids the Jeffrey's Ledge area. The applicant determined that those characteristics would decrease dramatically the technical feasibility of installing cable along the route (Earth Tech 2000a).

Nonburial Option

The applicant considered a nonburial option that would consist of laying cable along the Preferred Alternative route. Under that option, in waters deeper than 75 feet, the cable simply would be laid on the ocean bottom, rather than buried. To prevent damage by fishermen, the location of the cable would be charted as a restricted area in which dragging would be prohibited. Even given such precautions, unburied installation would leave both the cable and fishing gear more vulnerable to damage. For those reasons, the nonburial option was ruled out (Earth Tech 1999).

Satellite Data Transmission

The applicant evaluated a noncable option of replacing the proposed telecommunication and data transmission services with satellite communications. The use of communications satellites to provide the services identified as necessary would require no construction in the marine environment, but would not provide the capacity or quality of service proposed under the Hibernia project. The option does not meet the purpose of the project and therefore is not discussed in detail. In summary, the applicant determined that it would require more than 1,000 typical communications satellites to provide the same capacity as that proposed under the Hibernia Project. For the project's stated purpose and need, fiber-optic cables also are the only technology that can provide the desired capacity, transmission quality (as measured by bit error rate), and transmission delay required for modern data networks, including the Internet and corporate data networks.

3.0 AFFECTED ENVIRONMENT

The applicant proposes to traverse approximately 19.49 km of the Stellwagen Bank NMS, which is located approximately 25 nautical mi east of Boston, MA at the eastern edge of Massachusetts Bay. Stellwagen Bank NMS occupies an area of approximately 638 square nautical mi (842 square mi), extending from Cape Ann to Cape Cod, MA. Stellwagen Bank, an important geologic feature located within the sanctuary, measures approximately 18.75 mi long and 6.25 mi wide at its widest point (NOAA 1993, cited in Earth Tech 1999). The Preferred Alternative route is located north of Stellwagen Bank, but near the southern extent of Jeffrey's Ledge, another important geologic feature, which extends northward from the sanctuary into the Gulf of Maine.

In recognition of its environmental and commercial importance, Stellwagen Bank, along with the adjacent area, was proposed to become the nation's eleventh national marine sanctuary in 1989 and was officially designated on November 4, 1992. A management plan and regulations have been developed for the sanctuary to protect its resources, while providing for compatible commercial uses of the area.

The following subsections describe the existing conditions of the environmental, social, and economic resources of and in the vicinity of the Stellwagen Bank NMS. This baseline information was compiled from available data on the sanctuary, and is substantially adopted from the "Draft Environmental Assessment: Hibernia Transatlantic Project" (Earth Tech 1999). In instances where data were not available for the sanctuary itself, data on the general region were used to characterize the resources in the sanctuary. Section 3.0 Affected Environment and Section 4.0 Environmental Consequences of Proposed Action and Alternatives are based on the best available information on the Stellwagen Bank NMS and the area in proximity to the Northern Alternative. There is a lack of specific, detailed data available on these areas. For example, there is insufficient data available to characterize the quality of the benthic habitats that lie along the two potential cable routes.

Discussed below are:

- Water resources, including water quality and sources of pollution
- Geologic resources, including sand, sediment, and mining operations
- Biological resources, including fish species, benthos, and marine mammals
- Socioeconomic resources, including recreation and commercial fishing and shipping
- Cultural and historical resources, including shipwrecks

Several resource areas are not considered in this analysis because it was determined that they were not applicable to the alternative actions. Those resources include air quality, transportation (beyond commercial fishing and shipping), hazardous materials, and safety and health. Air quality and transportation were not considered in this analysis because the presence of one ship in the area for approximately two days does not constitute a substantial increase over current levels of vessel traffic. Hazardous materials were not considered in this analysis because cable installation does not involve the use or handling of any hazardous materials. Safety and health were not considered because it is assumed that cable installation personnel are governed by company established guidelines for at-sea operations and installation of cable.

3.1 WATER RESOURCES

The waters of the Stellwagen Bank NMS are characteristic of the waters of Massachusetts Bay and are fully marine, with salinity averaging approximately 32 parts per thousand (ppt). Water temperatures range from near freezing in late winter months to a high of approximately 63 degrees (º) Fahrenheit (F) in late summer. Sediment load varies seasonally, depending on the influx of freshwater, as well as tropical storms. Water quality in the project area and sources of pollution are discussed below.

3.1.1 Water Quality

Studies indicate that there are detectable levels of water pollution throughout Massachusetts Bay, including the areas proposed as the locations of both alternative routes. Detectable pollution includes elevated levels of metals, petroleum products, and polychlorinated biphenyls (PCBs) (Pett and McKay 1990, cited in Earth Tech 1999). Research is insufficient to support determination of the specific distribution of pollutants or their effects on natural resources in Massachusetts Bay, or in the Stellwagen Bank NMS in particular. The following information, taken from various sources included on the Stellwagen Bank NMS Web page (USGS/NOAA 1996, cited in Earth Tech 1999), summarizes what is known about contaminant levels as they may affect water quality along the proposed Hibernia cable route.

Several studies have sampled levels of water contaminants in proximity to the Stellwagen Bank NMS, and compared those levels with the U.S. Environmental Protection Agency's (EPA) acute and chronic water quality criteria for marine waters and with the maximum acceptable toxicant concentrations (MATC). For reference, the MATC generally is the same or higher than the corresponding EPA marine chronic value. Studies conducted in 1973 and 1974 identified levels of copper, lead, and mercury in excess of the EPA marine chronic criteria for those contaminants, but in general not in excess of the MATC. A more recent study, conducted in 1992 by Battelle Ocean Sciences, analyzed the waters of Massachusetts Bay for 16 polycyclic hydrocarbon (PAH) compounds, PCBs, selected pesticides, and 8 trace metals. That study identified no exceedances of EPA criteria or MATCs. A 1987 Battelle Ocean Sciences study of the waters of Stellwagen Basin showed levels of metals and PAHs below the water quality criteria (USGS/NOAA 1996, cited in Earth Tech 1999).

3.1.2 Sources of Pollution

The Gulf of Maine, and in particular the Massachusetts Bay area, including the Stellwagen Bank NMS, is subject to anthropogenic influxes of inorganic and organic contaminants from a variety of point and non-point sources (USGS/NOAA 1996, cited in Earth Tech 1999). Primary sources of pollution include wastewater discharges and combined sewer overflow, riverine discharge (particularly from the Merrimack River), active dredge disposal sites, and atmospheric deposition. Waste disposal and active dredge disposal sites contribute to pollution levels in their immediate areas, and have a lesser potential to contribute to water contamination within the Stellwagen Bank NMS through remobilization of sediments (USGS/NOAA 1996 cited in Earth Tech 1999). Table 3-1 provides a summary of the categories of potential sources of pollutants in the region.

Point Sources

Massachusetts Bay receives wastewater discharges from 13 municipal wastewater treatment plants (Maciolek and Menzie 1990, cited in Earth Tech 1999). The Massachusetts Water Resources Authority is completing construction of the Deer Island Ocean Outfall, which will discharge treated wastewater into coastal waters 16.4 mi from the western boundary of the Stellwagen Bank NMS. It is anticipated that new treatment technologies to be used at that facility will remove 90 percent of most contaminants through secondary treatment, thereby decreasing current levels of such wastewater contaminants as metals and nutrients (Maciolek and Menzie 1990, cited in Earth Tech 1999). In addition, industrial discharges permitted under the National Pollutant Discharge Elimination System may result in the discharge of elevated levels of contaminants into ocean waters. Effluents from combined sewer overflows, when stormwater discharges combine with wastewater discharges, can contribute petroleum compounds, metals, PAHs, and PCBs to receiving waters (Pett and McKay 1990, cited in Earth Tech 1999).

Table 3-1: Potential Sources of Water and Sediment Contamination in the Gulf of Maine, Particularly in the Stellwagen Bank Area.

POINT SOURCES
Discharges from wastewater treatment plants (WWTP)
• 13 in area
• Deer Island Ocean Outfall, Boston, Massachusetts, to come into use 16.4 mi from the western boundary of the Stellwagen Bank NMS
Industrial discharges (some in combination with WWTPs)
Combined sewer overflow (stormwater and sewage)
Massachusetts Bay Disposal Site (an active dredge disposal area since 1977)
Former Boston Foul Site or Industrial Waste Site
• Active from 1950s through 1977
• Undocumented dumping of hazardous and non-hazardous wastes
• Included low-level radioactive waste site from 1952 to 1960
NON-POINT SOURCES
River Discharges into northern Gulf of Maine, especially Merrimack River
Discharges from boat traffic
Atmospheric deposition

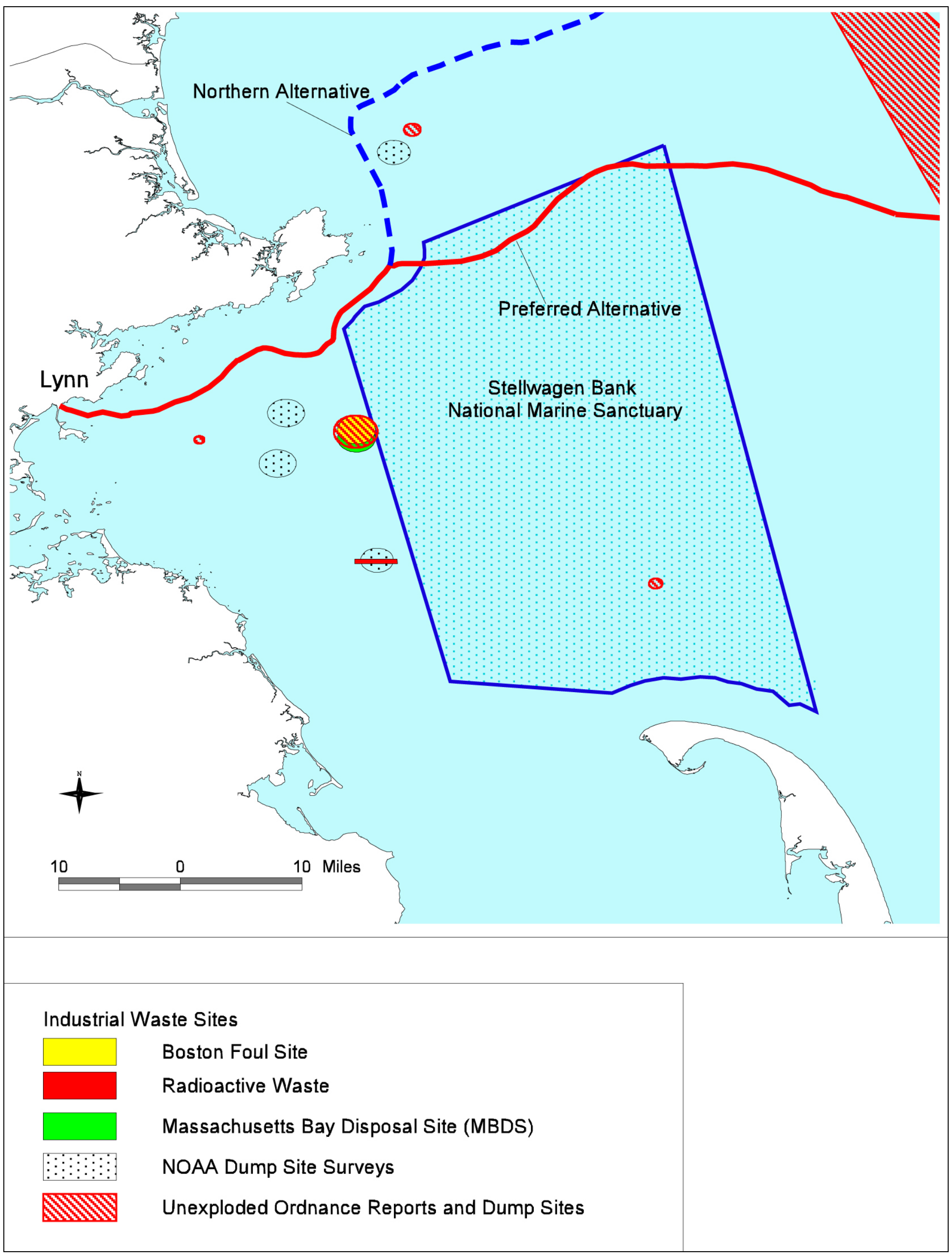
Source: Maciolek and Menzie 1990; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999.

Several areas of Massachusetts Bay, in close proximity to the northwest corner of the Stellwagen Bank NMS, historically have been used for disposal of low-level radioactive waste and toxic waste and, historically to the present, for disposal of dredge spoil (see Figure 3-1). Since the 1940s, the Stellwagen Basin area, just to the west of the Stellwagen Bank NMS, has been used to dispose of low-level radioactive waste, explosives, toxics and other industrial waste, construction debris, and dredged material. The Stellwagen Basin area has been used for disposal because of its proximity to Boston, its depth (60 to 100 m), and its depositional nature (Pett and McKay 1990, cited in Earth Tech 1999). Much of that early use was unregulated.

From 1952 to 1960 the area known as the Boston Foul Site or Industrial Waste Site was used for the disposal of low-level radioactive waste. Radioactive material, primarily from hospitals and research facilities, was encased in reinforced concrete designed to resist corrosion by seawater. Testing of the area performed by EPA in 1981 and 1982 indicated that the levels of radioactivity in commercial fish species and in sediments were at or below ambient levels, indicating that the area was not a significant source of radioactivity (Pett and McKay 1990, cited in Earth Tech 1999). There is little documentation related to the dumping of toxic wastes at the Boston Foul Site, which was closed in 1977. However, there is evidence that containers of waste are present throughout the area. It is likely that contaminants include halogenated organic compounds and heavy metals, among other substances (Pett and McKay 1990, cited in Earth Tech 1999). In 1970, the U.S. Food and Drug Administration (FDA) issued a warning notice about the harvesting of fish species and shellfish in the contaminated area, and the area has been closed to fishing for surf clams and quahogs by NMFS since 1980 (Dorsey 1990, cited in Earth Tech 1999).

The Massachusetts Bay Disposal Site (MBDS) is a circular area, 3.7 km in diameter, located 22.23 km southeast of Gales Point. The MBDS has been an active dredge disposal area since 1977, although its location, which overlaps the Boston Foul Site, has changed slightly over the years. The MBDS receives dredge spoil from harbors and waterways along the entire coast of Massachusetts Bay, but predominantly from Boston Harbor (NOAA 1993, cited in Earth Tech 1999). Likely contaminants include metals and

Figure 3-1: Location of Disposal Areas in Massachusetts Bay (USGS, 2000)



PCBs. The area is one of the most active dredge disposal sites in New England (Maciolak and Menzie 1990, cited in Earth Tech 1999). It is projected that over the next 50 to 100 years, the area will receive from 11.7 to 23.3 million cubic yards of dredge soil. That quantity of material could raise the seabed by as much as 0.8 to 1.6 m, if evenly dispersed. Recent monitoring studies that included sampling at the active disposal buoy determined that disposal of dredged material at MBDS is not impeding benthic recolonization (Pett and McKay 1990, cited in Earth Tech 1999).

Non-Point Sources

Non-point sources of pollutants also may have a significant impact on Massachusetts Bay. River discharges into the Gulf of Maine can contribute nutrients and toxics to coastal waters. In particular, the Merrimack River has a freshwater plume that reaches around Cape Ann and can be a significant source of metals, PAHs and PCBs (Maciolak and Menzie 1990, cited in Earth Tech 1999). Non-point sources of pollutants also include river discharges into the northern Gulf of Maine from the Piscataqua, Saco, Androscoggin and Kennebec rivers. Atmospheric deposition, particularly of metals and nutrients, can be a significant source of pollution of coastal waters and can carry pollutants from distant sources. Finally, discharges from boat traffic, including discharges of sanitary waste and bilge water, fuel oil spills, and disposal of general debris, can contribute nutrients, petroleum compounds, and metals to the water and sediments.

3.2 GEOLOGIC RESOURCES

Stellwagen Bank, as well as similar submerged banks along the northeastern coast of the U.S., were created by advances and retreats of glaciers. Banks and ridges in the Gulf of Maine are described as having an underlying layer of gravel and boulders. Gravel and sand are typical substrates in the near-shore areas (Hassol 1987; Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). Four sediment types have been described for the Gulf of Maine region: gravel, sand, silt-sand, and silt-clay (Wigley 1968, cited in Earth Tech 1999). Table 3-2 shows the percentages of sediment types traversed by each alternative route.

Table 3-2: Percentages of Bottom Types Along the Alternative Routes

Bottom Type	Preferred Alternative (within SBNMS)	Northern Alternative
Gravel (mixed coarse)	14%	5%
Sand	35%	10%
Mud	46%	55%
Mud (Silt-Clay)	5%	30%
Totals	**100%**	**100%**

Source: Seafloor Surveys International, Inc. 1999

Stellwagen Bank has surficial sediments that are primarily sands, flanked to the east by gravels and gravelly-sands. Minor quantities of gravel are associated with sand on Stellwagen Bank. Bottom sediments in the area of Stellwagen Bank NMS have been described as mostly sand, except for some patches of gravel on the eastern portion of the bank. It also has been noted that sand-silt and silt-clay sediments are found in areas adjacent to Stellwagen Bank (Pett and McKay 1990, cited in Earth Tech 1999).

Jeffrey's Ledge, which lies north of Stellwagen Bank, is composed primarily of gravels or gravelly-sand, flanked by a sandy area to the southeast. No specific information is available about the entire area around the northern perimeter of Jeffery's Ledge; therefore, information must be inferred from what is known about nearby areas. The nearby areas are characterized by unconsolidated marine sediments, similar to those in the areas east of Stellwagen Bank (Earth Tech 1999).

Pigeon Hill is a glacially eroded off-shore pinnacle, located on the south-central portion of Jeffrey's Ledge, 37 km from Cape Ann, MA. The knoll rises from a mud bottom 125 m deep to within 30 m of the surface. The area is described as relatively pristine and in the midst of a commercial fishing area. The benthic communities in the area are composed primarily of northern species that can tolerate significant disturbance. In addition, there are observable and quantifiable differences among communities of horizontal and vertical substrata, as well as with depth (Hulbert et al.1982, cited in Earth Tech 1999).

Areas between Stellwagen Bank and Jeffrey's Ledge are covered with sand mixed with some gravel. To the east of Stellwagen Bank NMS, extending into Wilkinson's Basin, there is a more depositional environment, with a higher percentage of silts within the sandy substrates (NOAA 1993, cited in Earth Tech 1999). The following sections describe sediment contaminants, mining of sand and gravel, and offshore oil and gas activity in the vicinity of the Stellwagen Bank NMS.

Sediment Contaminants

The concentrations of contaminants within sediments, as well as their bioavailability, vary according to the composition and particle size of the sediment. Depositional areas, such as Stellwagen Basin, tend to have higher concentrations of contaminants than higher-energy areas, such as the surfaces of Stellwagen Bank. Methods of assessing the potential effects of contaminants in sediment must take those various factors into consideration. One index EPA commonly uses is the Apparent Effects Threshold (AET), which is a correlative index defined as the concentration of contaminants in sediment above which an adverse biological effect always is observed statistically (USGS/NOAA 1996, cited in Earth Tech 1999).

A 1976 study of concentrations of metals and PCBs in sediments in Massachusetts Bay identified slightly elevated concentrations of the metals chromium, mercury, nickel, lead, and zinc, particularly in the depositional Stellwagen Basin; however, few measurements exceeded the AET values for lead and zinc, and there were no exceedances for cadmium, chromium, or PCBs. A 1979 study of concentrations of PAHs in Massachusetts Bay identified levels below the AET values. Other studies confirm a low level of contamination of sediment compared with levels that exceed toxicity criteria. Significantly elevated levels of metals, PCBs, and PAHs have been found within and near the MBDS; those findings are within the range of levels that are likely to cause adverse effects on marine biota (Pett and McKay 1990, cited in Earth Tech 1999).

In summary, on the basis of limited data, the majority of sediments in Massachusetts Bay, including those within the Stellwagen Bank NMS, are impacted by metals, PAHs, PCBs, and pesticides at levels that do not exceed of marine toxicity criteria established by EPA. The areas of Stellwagen Basin near the MBDS and the Boston Foul Site have significantly contaminated sediments that are more likely than other sediments in Massachusetts Bay to have an adverse effect on ocean life. However, few, if any, studies have measured levels of contaminants in marine biota from the area to assess potential toxic effects (Earth Tech 1999).

Mining of Sand and Gravel

Sand and gravel are used extensively in the construction industry and also in beach nourishment projects. In recent years, use and demand for sand and gravel resources have increased in the Boston metropolitan area. Several factors, including proximity to Boston, have combined to make off-shore mining of sand

and gravel an attractive alternative to land mining. However, mining of sand and gravel in the Stellwagen Bank NMS is prohibited expressly by statute (Public Law 102-587, subtitle B, Section 2202, cited in Earth Tech 1999).

Offshore Oil and Gas Activity

Stellwagen Bank is located within the northwest section of the North Atlantic Planning Area of the Atlantic Outer Continental Shelf (OCS) Region. Within the planning area, the Gulf of Maine has been identified as an area of hydrocarbon potential. However, no OCS oil or gas lease sales have been made in the area of the Stellwagen Bank NMS (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999).

3.3 BIOLOGICAL RESOURCES

The following discussion of biological resources focuses on areas of unconsolidated sediment, since the site of the project has been selected to avoid rocky and hard-bottom areas to facilitate burial of the cable. In the case of some of the following resource descriptions, information about the exact area of the cable route is not readily available. Much more information about Stellwagen Bank and nearby Georges Bank is available. Some of the descriptions therefore may present information that relates to widespread distribution or may have been inferred for the project area.

Biological resources are presented in six categories, corresponding to the type of organisms described. Section 3.3.1 discusses fish species and essential fish habitat (EFH) of the region. Section 3.3.2 describes benthic communities, including vegetation and animals, that frequent the ocean floor in the vicinity of the Stellwagen Bank NMS. Section 3.3.3 describes the marine mammals that have been found in the area. Sections 3.3.4 and 3.3.5, respectively, describe the marine reptiles and birds of the area. Section 3.3.6 describes the plankton (both phyto- and zooplankton) found in the Stellwagen Bank NMS area.

Practically every northwest Atlantic threatened or endangered species of sea turtle and marine mammal has been documented somewhere along the proposed cable-laying route (Kurkul 2000). Threatened and endangered species, as defined and protected under the Endangered Species Act (ESA), 16 U.S.C. 1531 *et seq*., are discussed in each section as relevant. Table 3-3 presents a summary of the threatened and endangered species found in the vicinity of the Stellwagen Bank NMS.

Table 3-3: Threatened and Endangered Species Found in the Vicinity of the Stellwagen Bank NMS

COMMON NAME	SCIENTIFIC NAME	LISTED STATUS
Humpback whale	*Megaptera novaeangliae*	Endangered
Northern right whale	*Eubalaena glacialis*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Blue whale	*Balaenoptera musculus*	Endangered
Loggerhead turtle	*Caretta*	Threatened
Green Sea turtle	*Chelonia mydas*	Threatened
Atlantic or Kemp’s ridley turtle	*Lepidochelys kempi*	Endangered
Leatherback turtle	*Dermochelys oriacea*	Endangered
Roseate tern	*Sterna dougallii*	Endangered

Source: Earth Tech 1999

3.3.1 Fish Species and Habitat

At least 141 species of fish, many of which commonly are found within the Stellwagen Bank NMS (see Appendix E), have been documented in Massachusetts Bay. The geographic and thermal transition zone that occurs at Cape Cod, which separates the Gulf of Maine from the Mid-Atlantic region, supports such extensive diversity of species. The transition zone provides the variety of habitats essential to the life cycles of many fish species (see tables 3-4 and 3-5). The Gulf of Maine primarily supports northern, non-migratory species. Many of the pelagic species, such as herring, tuna, and menhaden, show seasonal migratory movement in conjunction with changes in water temperature. Seasonal movements of most of the demersal species, such as flounder, are confined to changes in the Gulf of Maine. The greatest diversity of fish species is usually found in the autumn (Earth Tech 2000b).

Table 3-4: Summary of Essential Fish Habitat (EFH) of Commercially Important Species Present in Northern Stellwagen Bank National Marine Sanctuary

Common Name	Scientific Name	Life Stages Present			
		Eggs	Larvae	Juveniles	Adults
Atlantic cod	*Gadus morhua*	*X*	*X*	*X*	*X*
Haddock	*Melanogrammus aeglefinus*	*X*	*X*	*X*	*X*
Pollock	*Pollachius virens*	*X*	*X*	*X*	*X*
Red hake	*Urophycis chuss*	*X*	*X*	*X*	*X*
White hake	*Urophycis tenuis*	*X*	*X*	*X*	*X*
Silver hake (whiting)	*Merluccius bilinearis*	*X*	*X*	*X*	*X*
Redfish	*Sebastes faciatus*	*N/A*	*X*	*X*	*X*
Witch flounder	*Glyptocephalus cynoglossus*	*X*	*X*	*X*	*X*
Winter flounder	*Pleuronectes americanus*	*X*	*X*	*X*	*X*
Yellowtail flounder	*Pleuronectes ferruginea*	*X*	*X*	*X*	*X*
Windowpane flounder	*Scopthalmus aquosus*		*X*		
American plaice	*Hippoglossoides platessoides*	*X*	*X*	*X*	*X*
Ocean pout	*Macrozoarces americanus*	*X*	*X*	*X*	*X*
Atlantic halibut	*Hippoglossus hippoglossus*	*X*	*X*	*X*	*X*
Atlantic sea scallop	*Placopecten magellanicus*	*X*	*X*	*X*	*X*
Atlantic sea herring	*Clupea harengus*	*X*	*X*	*X*	*X*
Monkfish	*Lophius americanus*	*X*	*X*	*X*	*X*
Long-finned squid	*Loligo pealei*	*N/A*	*N/A*		*X*
Short-finned squid	*Illex illecebrosus*	*N/A*	*N/A*		*X*
Atlantic mackerel	*Scomber scombrus*	*X*	*X*	*X*	*X*
Spiny dogfish	*Squalus acanthias*	*N/A*	*N/A*	*X*	*X*
Blue shark	*Prionace glauca*				*X*
Porbeagle shark	*Lamna nasus*				*X*
Bluefin tuna	*Thunnus thynnus*			*X*	*X*

Source: NOAA 1999. Guide to Essential Fish Habitat Designations in the Northeastern United States. Volume II: Massachusetts and Rhode Island. NMFS, cited in Earth Tech 2000b.

Table 3-5: Summary of EFH Present Within the Northern Alternate Route

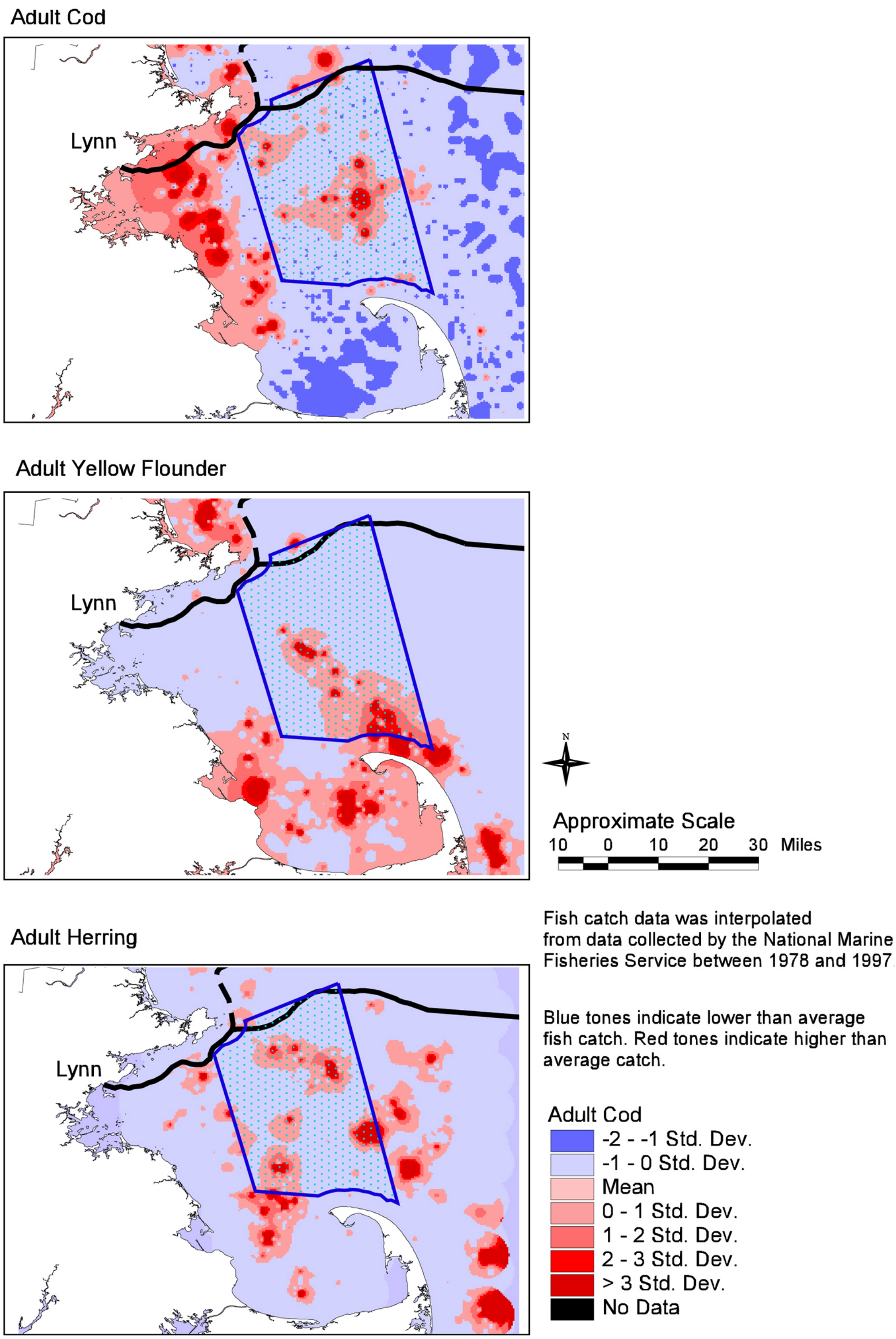
Common Name	Scientific Name	Life Stages Present			
		Eggs	Larvae	Juveniles	Adults
Atlantic cod	*Gadus morhua*	X	X	X	X
Haddock	*Melanogrammus aeglefinus*	X		X	X
Pollock	*Pollachius virens*	X	X	X	X
Whiting	*Merluccius bilinearis*	X	X	X	X
Red hake	*Urophycis chuss*	X	X	X	X
White hake	*Urophycis tenuis*	X	X	X	X
Redfish	*Sebastes faciatus*	N/A	X	X	X
Witch flounder	*Glyptocephalus cynoglossus*	X	X	X	X
Winter flounder	*Pleuronectes americanus*	X	X	X	X
Yellowtail flounder	*Pleuronectes ferruginea*	X			
American plaice	*Hippoglossoides platessoides*	X		X	X
Ocean pout	*Macrozoarces americanus*	X	X	X	X
Atlantic halibut	*Hippoglossus hippoglossus*	X	X	X	X
Atlantic sea scallop	*Placopecten magellanicus*	X	X	X	X
Atlantic sea herring	*Clupea harengus*	X	X	X	X
Monkfish	*Lophius americanus*	X	X	X	X
Bluefish	*Pomatomus saltatrix*				
Long-finned squid	*Loligo pealei*	N/A	N/A		
Short-finned squid	*Illex illecebrosus*	N/A	N/A		X
Spiny dogfish	*Squalus acanthias*	N/A	N/A	X	X
Bluefin tuna	*Thunnus thynnus*				X
Porbeagle shark	*Lamna nasus*				X
Blue shark	*Prionace glauca*				X

Source: NMES 1999. Guide to Essential Fish Habitat Designations in the Northeastern United States. Volume II: Massachusetts and Rhode Island. Cited in Earth Tech 2000b.

Several of the fish species use the area for spawning or seasonal feeding. Many species, including cod, haddock, silver hake, American plaice, and witch flounder, breed on Stellwagen Bank, but not in the deeper waters of the Gulf of Maine. The American sand lance spawns at Stellwagen Bank and forms an important link in the trophic chain from the zooplankton, on which the sandlance preys, to its predators, including cod, haddock, silver hake, yellowtail flounder, striped bass, bluefish, and several species of whale. Other species known to spawn in the Gulf of Maine include fourbeard rockling (April through June), witch flounder (March through June), Atlantic herring (August through October), and Atlantic cod (December through April). Massachusetts Bay is the primary spawning ground of the only known species of pollock in the northwest Atlantic (October through March) (Earth Tech 1999).

The Gulf of Maine is one of the most heavily fished areas in the United States. Therefore, commercial fishing is an important industry in the region (see Section 3.5, Socioeconomic Resources). More than 20 species of fish found in the area are important commercially and many of those species are described below (USGS/NOAA 1996, cited in Earth Tech 1999). Major areas of fish species habitat in Massachusetts Bay are shown in Figure 3-2.

Figure 3-2: Massachusetts Bay Fish Species Habitat (USGS 2000)



The Atlantic cod is a demersal to midwater fish, ranging from surf to 366 m (Pett and McKay 1990, cited in Earth Tech 1999). Cod can grow to 90 kilograms (kg); however, in the area, they generally do not grow larger than 7 kg or 8 kg. Cod can reach an age of 22 years. They prefer rocky or pebbly bottoms. These fish forage for clams, crabs, shrimp, worms, squid, and many fish species; larger cod may eat skates, flatfish, and even sculpin and searobins. Cod are cool-water fish, and regional abundance varies seasonally (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). These fish spawn primarily during the winter in the Gulf of Maine region.

Haddock are bottom-feeders, foraging for crabs, worms, clams, and sometimes fish (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). Haddock are found on sand and gravel bottoms, in waters varying in depth from 45 to 135 m (Pett and McKay 1990, cited in Earth Tech 1999). These fish prefer cool waters and, in the summer and fall, migrate northeastward from most locations. Haddock can reach an age of 18 years and obtain 122 cm in length. Haddock always have been a highly prized commercial species; small haddock may be known more familiarly as “scrod.” In the 1970s, the Georges Bank haddock fishery collapsed; currently, it has not recovered completely (Avarovitz and Grosslein, 1987, cited in Earth Tech 1999).

Pollock generally are found in large, fast-swimming schools, frequenting almost all depths and feeding on large zooplankton and other fish species. They generally are 4 to 7 kg in weight, but have been known to exceed 30 kg. Pollock prefer cool water and rough bottoms; they often are found near wrecks. These fish migrate seasonally to follow cooler waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Three species of hake are commercially important in New England regional fisheries: red hake, white hake, and silver hake. Red hake are generally 50 cm in length and 2 kg in weight (Avarovitz and Grosslein 1987, cited in Earth Tech 1999), but can reach a maximum of 75 cm in length (Brown 1987, cited in Earth Tech 1999). They migrate seasonally according to water temperature. Red hake can be found from the Gulf of St. Lawrence to North Carolina. Juveniles live in empty scallop shells; presumably, an instinctive protective measure. These fish are palatable when fresh, but do not keep well; their usefulness to a directed commercial fishery therefore is limited. Red hake often are confused with white hake, especially as juveniles. Both species occur throughout the region, although white hake generally are found farther to the north.

Silver hake also are known as “whiting.” These fish prefer warmer waters than do most of the other members of the cod family, and range from the Newfoundland Banks to South Carolina (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). These fish are voracious feeders that range throughout the water column, preying primarily upon other fish species and squid. These fish are important commercial fishery resources for the New England region (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). Silver hake reach a maximum length of 66 cm; females of the species can live to 12 years of age while males live only for some 6 years. Silver hake spawn principally in July and August in the Gulf of Maine area.

Redfish, also known as “ocean perch,” generally are found in deep waters, where they remain on the bottom during the day. At night, they feed near the surface. Redfish grow extremely slowly; it often takes 10 years for an individual to reach a length of 20 cm. Such a slow growth rate coupled with the fact that they are taken easily by trawlers while on the bottom during the day makes them especially vulnerable to overfishing (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Three species of flounder are considered to be of commercial importance in New England fisheries: winter flounder, witch flounder, and yellowtail flounder. Winter flounder are also known as “blackback,” and are sought after for sport fishing, as well as commercial fishing. These fish range from Labrador to Georgia. They can grow to 62 cm in length and attain an age of 12 years. They are sedentary fish, preferring soft, muddy or sandy bottoms. In winter, coastal populations move into very shallow or estuarine waters to spawn. Winter flounder feed during the day, primarily on small invertebrates (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Witch flounder are most common along the continental shelf of Georges Bank in waters 300 to 450 m deep. They are demersal, preferring fine, soft ground between rocky patches. These fish also are known as "gray sole" and feed primarily on small invertebrates, rarely eating other fish species (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Yellowtail flounder can reach 65 cm in length; however, most individuals caught currently are less than 50 cm long. As adults, they are found distributed widely in waters 10 m to 100 m deep, on sandy or sandy-mud bottoms; they avoid soft mud or hard, rocky bottoms (Avarovitz and Grosslein 1987; Pett and McKay 1990, cited in Earth Tech 1999). Juveniles prefer rough bottoms, which offer more protection than other environments (Avarovitz and Grosslein, 1987, cited in Earth Tech 1999). Yellowtail flounder can reach a maximum age of some 14 years. Heavy fishing has had a strong affect on spawning populations of yellowtail flounder (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

American plaice are bottom-dwelling fish that have a small midwater foraging range (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They prefer sand-mud bottoms and are concentrated in the Gulf of Maine, from 150 to 250 m deep (Pett and McKay 1990, cited in Earth Tech 1999). They are not migratory and regional populations can be distinguished physiologically from one another. American plaice forage for a variety of invertebrates and rarely eat other fish species. Juvenile plaice are preyed upon by many species, but adults are prey only for halibut, dogfish, and other large predators. This fish prefers cold waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Atlantic sea herring are pelagic fish found widely distributed throughout the Gulf of Maine (Avarovitz and Grosslein 1987; Pett and McKay 1990, cited in Earth Tech 1999). Herring are migratory, but maintain individual populations in certain areas. They range from polar ice in Greenland to Cape Hatteras. They can grow to 44 cm, and live to an age of 18 years. These fish feed on copepods, euphausiids, mollusk larvae, and other fish species eggs, primarily in the upper water column (Avarovitz and Grosslein 1987, Pett and McKay 1990, cited in Earth Tech 1999). They in turn are preyed upon by many fish species, as well as seabirds, porpoises, and whales. In the 1960s and 1970s, the herring population of Georges Bank was decimated by intense fishing activity, and the fishery collapsed altogether in 1977. Because of the tendency of these fish to maintain discreet populations, there has been no appreciable increase in herring populations on Georges Bank since that collapse (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

The Atlantic mackerel is a pelagic fish of commercial importance that moves inshore in the Gulf of Maine region during spring (Pett and McKay 1990, cited in Earth Tech 1999). These fish range from Labrador to North Carolina. Mackerel can reach an age of 18 to 20 years and a maximum length of 56 cm. In spring and early summer, mackerel spawn in the Gulf of Maine region.

Spiny dogfish are voracious predators of almost any species smaller than themselves and therefore have a significant effect on the populations of mackerel, herring, scup, cod, silver hake, and haddock. Spiny dogfish generally are 1 m in length and have no significant natural enemies (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They are abundant in the Gulf of Maine area, where they remain year-round, avoiding warm shallows. Spiny dogfish can live for 30 to 40 years but have a low reproductive potential. Females do not reach maturity until age 14 and generally do not produce more than four to six offspring in each two-year gestation period (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Atlantic bluefin tuna are important recreational and commercial fish in the Stellwagen Bank area (Jarvis 1990; Terkla 1990, cited in Earth Tech 1999). Atlantic bluefin are pelagic fish that are present in the Gulf of Maine from June to October (Pett and McKay 1990, cited in Earth Tech 1999).

American sand lances are eel-like fish that grow to, on average, 25 cm in length. They prey primarily on copepods, but also eat other fish species eggs and larvae. In turn, they are important in the diet of bluefish, cod, pollock, spiny dogfish, silver hake, and whales. Sand lances rely on sandy bottoms for habitat and, therefore, are found in somewhat patchy distributions. They do not migrate, and their geographic distributions do not vary significantly by season (Azarovitz and Grosslein 1987, cited in Earth Tech 1999).

Sculpins are not an important commercial species and are used by fishermen only for lobster bait. They are demersal fish, found on all types of bottoms (Avarovitz and Grosslein 1987, cited in Earth Tech 1999), often partially buried in bottom sediment. They play an important ecological role since they eat almost any bottom-dweller they encounter, including most invertebrates, other fish species' eggs, and juvenile fish of many important species. Sculpins are also an important forage species for carnivorous fish. They concentrate in the Great South Channel during fall.

Butterfish are schooling pelagic fish that migrate seasonally within the range from Georges Bank to Cape Hatteras. They are an important ecological link in the food web; butterfish eat jellyfish, copepods, and sometimes other small fish species and are themselves preyed upon heavily by squid, bluefish, and others. Commercially, they are fished for use in fish meal and as bait and, to a minor extent, as a foodfish. Most butterfish spawn in inshore waters (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Bluefish are a favorite of sport and commercial fishermen alike, but the recreational catch exceeds the commercial catch largely because bluefish have replaced stocks of striped bass, which currently are very low, as the main recreational fishery of the Middle Atlantic. These fish are voracious, fast-swimming predators that feed throughout the water column on fish species only slightly smaller than themselves. Bluefish have a wide range of distribution, but generally prefer warmer waters and migrate seasonally to follow water temperature (Avarovitz and Grosslein 1987, cited in Earth Tech 1999). They are fast-growing and can live for 14 years; they reach a maximum length of 114 cm.

Scup are an important commercial and recreational fish species, ranging from south of Georges Bank to Cape Hatteras. Scup are bottom-feeders and forage for small invertebrates. In late spring and summer, these fish move to inshore waters where they spawn (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

Cusk are members of the cod family that prefer hard, rocky bottoms and are found in deep, cold waters. These fish are solitary and are not extremely abundant throughout the Gulf of Maine area. Although they are harvested commercially, lack of abundance limits their usefulness for a directed fishery (Avarovitz and Grosslein 1987, cited in Earth Tech 1999).

3.3.2 Benthic Communities

The benthic infauna serve as an important food source for various life stages of the fish species that occur in the Stellwagen Bank NMS area. Benthic communities in the vicinity of the sanctuary have not been well characterized. Because data are limited, characterization has been inferred from the data collected during several evaluations of benthic communities conducted in the Georges Bank and the Gulf of Maine region. Data from studies of the structure of the benthic community performed in Massachusetts Bay within or near the boundary of the Stellwagen Bank NMS give some limited, but site-specific, information (Pett and McKay 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999). Blake and others (1998) presented the following benthic information from farfield research stations, which are research stations farther from shore, located in the vicinity of the project.

Conditions at most of the farfield stations appeared to be more stable, in terms of faunal communities, from year to year than those at the nearfield and midfield stations, since the farfield stations were at a distance from Boston Harbor and the influence of nearshore sediment transport processes. One station showed an affinity to the nearshore environment, is sandy, and is dominated by the *Spionid polychaetes, Prionospio steenstrupi, Spio limicola, and Dipolydora socialis*. Other species that were characteristic of the assemblage included the bivalves *Nucula delphinodonta* and *Thyasira gouldii*, the amphipod *Harpinia propinqua*, and the large burrowing polychaete *Aglaophamus circinata*. A second group of farfield stations near Stellwagen Basin were located in 62 to 87 m of water. These stations were silty with only moderate amounts of sand. The assemblage was characterized by six polychaetes and one oligochaete: *Chaetozone setosa*, *Aricidea quadrilobata*, *Levinsenia gracilis*, *Anobothrus gracilis*, *Mediomastus californiensis, Galathowenia oculata* and *Tubificoides apectinatus* (Blake 1998, cited in Earth Tech 1999).

Analysis of the species present at the research stations indicates that the benthic offshore environment in Massachusetts Bay differs consistently from the nearshore environment. Further, population densities at those stations located farther offshore than others were less variable and tended to be lower than those at the nearshore stations (Blake 1998, cited in Earth Tech 1999).

Table 3-6 presents phyla that are representative of the gravel community in the Gulf of Maine. They are: Porifera, Coelenterata, Arthropoda, Annelida, Mollusca, Echinodermata, and Chordata. On offshore banks made up of sand sediments in the Gulf of Maine, the following groups are dominant, as presented in Table 3-7: Crustacea, Annelida, Mollusca and Echinodermata. Table 3-8 shows phyla that are representative of the sand-silt benthic communities (sand-silt containing more than 25 percent organic matter). They are: Coelenterata, Arthropoda (Crustacea), Annelida, Mollusca, and Echinodermata. Phyla representative of silt-clay benthic communities found in deepwater basins in the Gulf of Maine include Arthropoda (Crustacea), Annelida, Mollusca, and Echinodermata. They are listed in Table 3-9.

Table 3-6: Benthic Organisms Associated with Gravel Sediments in the Gulf of Maine Region

Species	Common Name
Porifera	
Clionia sp.	Sponge
Myxilla sp.	Sponge
Polymastia sp.	Sponge
Coelenterata	
Bouganvillia sp.	Hydroid
Eudendrium sp.	Hydroid
Gersemia sp.	Hydroid
Paragoria sp.	Hydroid
Sertularia sp.	Hydroid
Tubularia sp.	Hydroid
Crustacea	
Balanus crenatus	Barnacle
B. hameri	Barnacle
Hyas sp.	Toad crab
Annelida	
Chone sp.	Polychaete
Serpula sp.	Polychaete
Spirorbis	Polychaete
Brachiopoda	
Terebratulina sp.	Lampshell

Table 3-6 (continued): Benthic Organisms Associated with Gravel Sediments in the Gulf of Maine Region

Species	Common Name
Mollusca	
Anomia sp.	Bivalve
Dendronotus sp.	Nudibranch
Doris sp.	Nudibranch
Modiolus modiolus	Bivalve
Musculus sp.	Bivalve
Neptunea sp.	Gastropod
Placopecten magellanicus	Bivalve
Echinodermata	
Crossaster sp.	Starfish
Ophiacantha sp.	Brittle star
Ophiopholis sp.	Brittle star
Solaster sp.	Starfish
Urochordata	
Amaroucium sp.	Tunicate
Ascidia sp.	Tunicate
Boltenia sp.	Tunicate

Source: Wigley 1968 cited in Earth Tech 1999.

Table 3-7: Benthic Organisms Associated with Sand Sediments in the Gulf of Maine Region

Species	Common Name
Crustacea	
Chiridotea sp.	Isopod
Crangon septemspinosis	Shrimp
Leptocuma sp.	Cumacean
Pagurus acadianus	Crab
Annelida	
Clymenella sp.	Polychaete
Goniadella sp.	Polychaete
Ophelia sp.	Polychaete
Mollusca	
Astarte castanea	Bivalve
Lunatia heros	Gastropod
Nassaurius trivitattus	Gastropod
Spisula soldissima	Bivalve
Echinodermata	
Echinarachnius parma	Sand dollar

Source: Wigley 1968 cited in Earth Tech 1999.

Table 3-8: Benthic Organisms Associated with Sand-Silt Sediments in the Gulf of Maine Region

Species	Common Name
Coelenterata	
Cerianthus sp.	Anemone
Crustacea	
Ampelisca compressa	Amphipod
A. radorum	Amphipod
Diastylis sp.	Cumacean
Dichelopandalus sp.	Shrimp
Edotea sp.	Isopod
Annelida	
Harmothoe sp.	Polychaete
Nephtys sp.	Polychaete
Scalibregma sp.	Polychaete
Mollusca	
Arctica islandica	Ocean quohog
Colus pygmaeus	Gastropod
Crenella sp.	Bivalve
Nucula sp.	Bivalve
Venericardia sp.	Bivalve
Echinodermata	
Amphilmna sp.	Brittle star
Amphiopholis sp.	Brittle star
Thyone scabra	Sea Cucumber

Source: Wigley 1968 cited in Earth Tech 1999.

Table 3-9: Benthic Organisms Associated with Silt-Clay Sediments in the Gulf of Maine Region

Species	Common Name
Crustacea	
Calocaris sp.	Shrimp
Geryon sp.	Crab
Haploops tubicola	Amphipod
Munnopsis typica	Isopod
Pandalus sp.	Shrimp
Annelida	
Amphitrite sp.	Polychaete
Leanira sp.	Polychaete
Onuphis sp.	Polychaete
Sternaspis sp.	Polychaete
Mollusca	
Cadulus sp.	Scaphopod
Dentalium sp.	Scaphopod
Modiolaria discors	Bivalve
Scaphander sp.	Gastropod

Table 3-9 (continued): Benthic Organisms Associated with Silt-Clay Sediments in the Gulf of Maine Region

Species	Common Name
Echinodermata	
Amphiura otteri	Brittle star
Briaster fragilis	Heart urchin
Ctenodiscus crispatus	Mud star
Ophiura robusta	Brittle star
O. sarsi	Brittle star
Urochordata	
Polycarpa fibrosa	Tunicate

Source: Wigley 1968 cited in Earth Tech 1999.

The specific benthic organisms in the area were determined by soil and sediment type. Results of sediment sampling conducted in Massachusetts Bay within or near the boundary of the Stellwagen Bank NMS indicated that diversity of species tended to increase offshore and with greater distance from Stellwagen Bank. There was a trend to a gradual decrease in faunal abundance off shore, which probably was related to increasing depth and decreasing food supply to the bottom. Numerically dominant species from these sets of sampling locations were polychaetes of the phylum Annelida and included: *Spio limicola*, *Prionospio streenstrupi*, *Aricidea quadrilobata*, and *Mediomastus californiensis*. The Spionid *Spio limicola* was the numerically dominant species at most of the sampling locations. The communities appeared fairly stable over time and also appeared to differ from communities observed on Georges Bank. In the Stellwagen Bank area, the species that make up the benthic community may differ from those in adjacent areas because of differences in sediment characteristics and productivity on the bank (USGS/NOAA 1996, cited in Earth Tech 1999).

Mollusks Important to Recreational and Commercial Harvesting

In the U.S. Exclusive Economic Zone (EEZ), short-finned squid (*Illex illecebrosus*) are targeted by small-mesh otter trawl fisheries near the edge of the continental shelf from June through September. The U.S. fishery is managed by the Mid-Atlantic Fishery Management Council, under the provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. Distribution is influenced strongly by oceanographic factors, and monitoring of the species can present problems. Peak spawning occurs during winter, and individuals from northern areas make a long spawning migration to waters off Cape Hatteras (NOAA 1998, cited in Earth Tech 1999).

Long-finned squid (*Loligo pealei*) are taken off southern New England, with effort directed offshore from October through March and inshore from April through September. The fishery is managed by the Mid-Atlantic Fishery Management Council. The fishery has small-mesh otter trawlers, but landings also are taken from pound nets and traps in spring and summer. Commercial exploitation ranges from Georges Bank to Cape Hatteras. The species migrates seasonally, moving offshore during late fall to overwinter in warmer waters and inshore to spawn in spring and early summer. These squid live for less than a year, grow rapidly and spawn year-round. Those characteristics make them a seasonally dynamic resource (NOAA 1998, cited in Earth Tech 1999).

Invertebrate Species Important to Recreational and Commercial Harvesting

Several invertebrate species are taken commercially in the Stellwagen Bank area (NOAA 1993, cited in Earth Tech 1999), including:

- American lobster (*Homarus americanus*)
- Northern Shrimp (*Pandalus borealis*)
- Atlantic Surf Clam (*Spisula solidissima*)
- Ocean Quahog (*Artica islandica*)
- Sea Scallop (*Placopecten magellanicus*)

The American lobster offshore fishery is managed under the New England Fishery Management Council's Lobster Fishery Management Plan. The species is abundant from coastal regions to depths of 700 m. Offshore lobsters make well-defined shoalward migrations during the spring. Eggs are carried under the female's abdomen during a 9 to 11 month incubation period. Eggs hatch during late spring or early summer, with the pelagic larvae undergoing four molts before displaying adult characteristics. They then settle to the bottom. The principal fishing gear used for lobsters is the trap. Lobsters also are caught with otter trawls. Recreational harvesting of lobsters occurs along coastal waters (NOAA 1998, cited in Earth Tech 1999).

The northern shrimp fishery is managed by restrictions on gear and imposition of seasonal limits (a 183-day "window" limit from December through May), under the authority of the Atlantic States Marine Fisheries Commission. Northern shrimp are harvested by otter trawl. In the Gulf of Maine, the shrimp inhabit soft, muddy bottoms at approximate depths of 10 m to 300 m. They occur most commonly in the southwestern Gulf of Maine. Spawning and egg extrusion occur in summer. In late fall, females move to coastal waters where eggs hatch during the wintertime. Juveniles remain near shore for more than a year and then migrate offshore as they mature (NOAA 1998, cited in Earth Tech 1999).

In the EEZ, the atlantic surf clam fishery is managed under the Surf Clam-Ocean Quahog Fishery Management Plan of the Mid-Atlantic Fishery Management Council. The main gear for harvesting surf clams is the hydraulic clam dredge. Commercial quantities of the species are present in southern New England waters. The surf clams are capable of reproduction in their first year of life, although they may not reach full maturity until the second year. Eggs and sperm are shed directly into the water column, and recruitment to the bottom occurs after a three-week larval period (NOAA 1998, cited in Earth Tech 1999).

In the EEZ, the ocean quahog fishery is managed under the Surf Clam-Ocean Quahog Fishery Management Plan of the Mid-Atlantic Fishery Management Council. The main gear for harvesting the ocean quahogs is the hydraulic clam dredge. In the Gulf of Maine, the species is found relatively near shore and is fishable from three to seven miles off shore. Ocean quahogs have a longevity of more than 100 years, with growth slow after age 20. A spawning is reported to occur over an interval from summer through autumn. The pelagic larvae develop slowly and may drift for more than 90 days (NOAA 1998, cited in Earth Tech 1999).

The sea scallop fishery is managed under the Fishery Management Plan for Atlantic Sea Scallops of the New England Fishery Management Council. Management measures can include moratoria on permits, restrictions on days-at-sea, restrictions on gear and crew size, and closing of areas. Sea scallops are harvested year-round, with dredges and otter trawls as the primary fishing gear. North of Cape Cod, the species is scattered in shallow waters, less than 20 m in depth. The principal U.S. commercial fisheries take place in inshore waters of the Gulf of Maine. Sea scallops grow rapidly in the first years of life. Sexual maturity commences at age two. Spawning occurs in late summer and early autumn. The eggs are buoyant, and larvae remain in the water column for four to six weeks before they settle to the bottom (NOAA 1998, cited in Earth Tech 1999).

3.3.3 Marine Mammals

Several species of marine mammals have been reported in the southwestern area of the Gulf of Maine including Stellwagen Bank (NOAA 1993, cited in Earth Tech 1999). Marine mammals regularly migrate seasonally through the region and Stellwagen Bank serves as both a feeding and a nursery area for marine mammals. It has been noted that seven species of cetaceans and one pinniped species use the area regularly (Clapham 1989, cited in Earth Tech 1999). Table 3-10 lists species of marine mammals reported to occur on Stellwagen Bank and in the Stellwagen Bank NMS.

Table 3-10: Marine Mammals Reported to Occur on Stellwagen Bank

Common Name	Scientific Name
Endangered Cetaceans	
Humpback whale	*Megaptera novaeangliae*
Northern right whale	*Eubalaena glacialis*
Fin whale	*Balaenoptera physalus*
Sei whale	*Balaenoptera borealis*
Blue whale	*Balaenoptera musculus*
Non-endangered Cetaceans	
Minke whale	*Balaenoptera acutorostrata*
Pilot whale	*Globicephala melaena*
Orca whale	*Orcinus orcus*
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
White-beaked dolphin	*Lagenorhynchus albirostris*
Harbor porpoise	*Phocoena phocoena*
Bottlenose dolphin	*Tursiops truncatus*
Common dolphin	*Delphinus delphis*
Striped dolphin	*Stenella coeruleoalba*
Grampus (Risso's) dolphin	*Grampus griseus*
Pinnipeds	
Harbor seal	*Phoca vitulina*
Gray seal	*Halichoerus grypus*

Source: Clapham 1989; Pett and McKay 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999.

Whales and Dolphins

Humpback whales are moderately large baleen whales. An adult may range from 35 to 50 feet long and weigh as much as 45 tons. In the Stellwagen Bank area, the endangered humpback whale occurs primarily during the spring (mid-March), summer, and fall. During late fall and early winter, most individuals leave the area and migrate to mating and calving grounds in the West Indies. The annual rate of return to Stellwagen Bank is reported to be high. The whales use Stellwagen Bank primarily for feeding and a principal food source in the area is the sand lance. Data suggest that Stellwagen Bank also is an important nursery ground (Clapham 1989; Mayo 1990; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered northern right whale reaches a maximum length of 50 feet. The general pattern of distribution of the species is in the Stellwagen Bank and Cape Cod area during the late winter and early spring months. The area serves as a nursery ground in the early spring. The whales generally remain in the area until July, when they begin to move farther north. By October, the whales have begun to migrate to the areas in which they winter. Northern right whales feed exclusively on zooplankton, which at Stellwagen Bank consist primarily of calanoid copepods and juvenile euphausiids (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered fin whale is the largest baleen whale sighted in the Stellwagen Bank area. The fin whale is most abundant on Stellwagen Bank in spring, summer, and fall, with some sightings in winter. Fin whales feed on herring and sand lance. Stellwagen Bank appears to be an important nursery ground for the species (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The endangered sei whale is smaller and darker than the fin whale and has been observed feeding on Stellwagen Bank. Sei whales feed on zooplankton, primarily copepods and euphausiids. Since 1986, the number of individuals recorded has been relatively low (Clapham 1989; Pett and MaKay 1990, cited in Earth Tech 1999).

The endangered blue whale is the largest of all the whales. It has been reported three times on Stellwagen Bank. When observed, the species was feeding, probably on euphausiids. Blue whales also may feed on copepods, squid, and fish species (Clapham 1989; Pett and McKay 1990, cited in Earth Tech 1999).

The minke whale is the smallest baleen whale in the North Atlantic. It commonly is seen in the Stellwagen Bank area during spring, summer, and fall (Clapham 1989, cited in Earth Tech 1999). The species has been seen in the northern area of Stellwagen Bank and southern Jeffrey’s Ledge from March until November. Minke whales feed primarily on schooling fish species and euphausiids (Pett and McKay 1990, cited in Earth Tech 1999).

The pilot whale, distinguished by the species’ large bulbous head, generally has been observed along the shelf edge (100 to 1,000 m contour), but also may be observed in the central and northern Georges Bank, the Great South Channel, and the Gulf of Maine region between May and October. Pilot whales feed on squid, with invertebrates and fish species as alternatives (Pett and McKay 1990, cited in Earth Tech 1999).

The orca whale has been reported in the southwestern Gulf of Maine from mid-July through September. The whales also are known to overwinter in the Gulf of Maine. They have been reported on Jeffrey’s Ledge southward to Stellwagen Bank. The species is an opportunistic feeder that eats various fish species, including bluefin tuna, and even seabirds and other cetaceans. In general, orcas are considered to be uncommon in the Gulf of Maine and infrequent visitors to Stellwagen Bank (NOAA 1993, USGS/NOAA 1996, cited in Earth Tech 1999).

The atlantic white-sided dolphin is common on Stellwagen Bank during spring and fall, from July through September. The species’ primary activity in the Stellwagen Bank area appears to be feeding. The dolphins feed on herring, squid, and sand lance (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The white-beaked dolphin reaches a maximum length of 10 feet. White-beaked dolphin are infrequent visitors to Stellwagen Bank. In the southern Gulf of Maine, the species occurs from April through November, with more spring sightings reported at Stellwagen Bank. The dolphins forage on squid and fish species (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

Harbor porpoises are the smallest cetaceans observed on Stellwagen Bank. They are common in the Stellwagen Bank region between April and May, with numbers decreasing by June. During summer, the species is more abundant in the northern Gulf of Maine and somewhat absent from the southwestern part, including Stellwagen Bank. It is thought that they move southward along the coast in the fall. Harbor porpoises feed primarily on herring and silver hake (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

The bottlenose dolphin usually occurs in the Gulf of Maine during late summer and fall. Occurrences of this dolphin in the Stellwagen Bank region are considered very rare, and it does not appear that the species uses Stellwagen Bank to any great extent (Clapham 1989; USGS/NOAA 1996, cited in Earth Tech 1999).

The common dolphin is recognized by an hourglass-shaped pattern on both sides of the body. Very few sightings have been recorded at the Stellwagen Bank. This species is an opportunistic forager (Clapham 1989; USGS/NOAA 1996, cited in Earth Tech 1999).

The striped dolphin is seen only occasionally in the Gulf of Maine. Striped dolphins feed primarily on fish species and squid (NOAA 1993, cited in Earth Tech 1999).

The Grampus (Risso's) dolphin has been observed infrequently in the Stellwagen Bank area during the summer and fall. The species is thought to feed exclusively on squid (NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999).

Seals

Harbor seals occur in southern New England, primarily from late September through May. They often are observed on Stellwagen Bank. After May, they move northward toward the coast of Maine. In general, harbor seals are opportunistic feeders that forage on fish species (Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

Gray seals have been observed with some frequency in the area in winter and early spring, and periodic sightings have been noted in the summer, as well. Gray seals feed mostly on fish species but will forage for invertebrates (Clapham 1989; Pett and McKay 1990; USGS/NOAA 1996, cited in Earth Tech 1999).

3.3.4 Marine Reptiles

Four species of marine turtles have been reported in Gulf of Maine waters, although only two of those species occur with any regularity (NOAA 1993, cited in Earth Tech 1999). The species are the Atlantic or Kemp's ridley turtle (*Lepidochelys kempi*); the Leatherback turtle (*Dermochelys oriacea*); the Loggerhead turtle (*Caretta*); and the Green sea turtle (*Chelonia mydas*).

Massachusetts is the northern tolerance limit for the federally-listed threatened loggerhead, with temperature the limiting factor, so they are not regular visitors to the area. Similarly, the federally-listed threatened green sea turtle is normally found in warmer waters, and only rarely in summertime within Cape Cod Bay.

The federally-listed endangered Atlantic ridley turtle occurs as juveniles in summer in waters off Massachusetts, after hatching in Mexico and traveling the Gulf Stream. Southern New England waters are important feeding grounds for the species (NOAA 1993, cited in Earth Tech 1999), although, according to some scientists, they may be only accidental visitors to the area, having been carried there by the currents of the Gulf Stream (Pett and McKay 1990, cited in Earth Tech 1999).

The federally-listed endangered leatherback turtle is a summer visitor in the Gulf of Maine, where it comes to feed on nektonic jellyfish and combjellies. Adults are observed primarily individually in late summer (NOAA 1993, cited in Earth Tech 1999). In fall, the leatherback moves farther offshore and migrates south. The leatherback is susceptible to human interference because the morphology and size of the species prevents the turtle from swimming backward. They therefore can become trapped in obstructions, such as fishing nets and lobster pot lines, and sometimes they collide with boats.

3.3.5 Marine Birds

More than 40 species of seabirds are commonly found in the southwestern Gulf of Maine in the vicinity of the project area (see Appendix F). In particular, these birds tend to frequent the vicinity of the Stellwagen Bank because of its nutrient-rich waters, which support the birds' diet of zooplankton and fish. The birds spend from 50 to 90 percent of their life cycles at sea, returning to land primarily to breed. With the exception of one species, Leach's storm petrel, the seabirds are either migrants or nonbreeding residents of the Stellwagen Bank area (Earth Tech 1999).

In any season, only 10 species account for more than 95 percent of the birds sighted (Pett and McKay 1990, cited in Earth Tech 1999). Table 3-11 shows the seasonal distributions and relative abundances of the dominant speices. The winter months are dominated by migratory kittiwakes and overwintering razorbills. Resident herring gulls and great black-backed gulls also are dominant. All feed primarily on fish species. The seabird populations are the least abundant in spring, although the gulls identified above are as abundant in that season as in winter.

Table 3-11: Common Seabird Species by Season at Stellwagen Bank

Species	Winter	Spring	Summer	Fall
Northern fulmar	6 [0.17%]	154 [6.00%]		
Greater shearwater	2 [0.05%]		4,165 [10.72%]	25,684 [39.92%]
Sooty shearwater		158 [6.15%]	1,819 [4.68%]	
Manx shearwater			345 [0.88%]	
Wilson's storm petrel		780 [30.40%]	24,213 [62.35%]	2,522 [3.92%]
Northern gannet	237 [6.83%]	438 [17.07%]	87 [0.22%]	6,786 [10.54%]
Common eider	21 [0.60%]			880 [1.36%]
Surf scoter				500 [0.77%]
Oldsquaw	13 [0.37%]			
Red-necked phalarope		91 [3.54%]		740 [1.15%]
Parasitic jaeger		20 [0.77%]	92 [0.23%]	
Herring gull	162 [4.67%]	377 [14.69%]	915 [2.35%]	1,028 [1.59%]
Great black-backed gull	340 [9.80%]	268 [10.44%]	336 [0.86%]	
Laughing gull			1,028 [2.64%]	1,025 [1.59%]
Bonaparte's gull	18 [0.51%]			
Black-legged kittiwake	1,615[46.56%]	158 [6.15%]		6,113 [9.50%]
Common tern			5,688 [14.64%]	16,042 [24.93%]
Razorbill	999 [28.80%]	13 [0.50%]		
Season Total	**3,413 [98.41%]**	**2,457 [95.79%]**	**38,688 [99.63%]**	**61,320 [95.32%]**

Source: For each species and season, the number of seabirds and percentage of all seabirds seen at Stellwagen Bank is provided. Data compiled from records of Manomet Bird Observatory 1979-1990, as reported in Pett and McKay, (1990), cited in Earth Tech 1999.

Kittiwakes, shearwaters, petrels, gannets, phalaropes, and fulmars all are present at Stellwagen Bank during their northern migrations. Those species feed primarily on zooplankton. In summer, petrels are very abundant, coincident with the zooplankton peak in late spring. Terns and shearwaters also become more abundant in late spring, and feed on fish, squid, and crustaceans. Various gulls are abundant in summer. In the fall, shearwaters and kittiwakes again are abundant because of the southern migration, along with terns and other species that migrate through the area (Earth Tech 1999).

3.3.6 Plankton

Both phytoplankton and zooplankton are found in the vicinity of the Stellwagen Bank NMS. Both are discussed below.

Phytoplankton

A diverse phytoplankton community dominated by several species of diatoms forms the basis of the food chain for many of the significant marine resources found in the Stellwagen Bank area and in the Gulf of Maine in general. Although little specific information about phytoplankton populations in the Stellwagen Bank area is available, table 3-12 lists the major species of phytoplankton found in the Gulf of Maine and Massachusetts Bay (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). It can be expected that the population over Stellwagen Bank is even more abundant than that of surrounding waters because of the upwelling of nutrients in the area of the bank. The highest concentrations of phytoplankton are found between December and early April and again in August. Population densities at other times of year are limited because of light and nutrient conditions. The major species of phytoplankton found in winter include *Coscinodiscus* and *Ceratium*, followed by blooms of *Thalassiosira* and *Chaetoceros* in the spring, when the critical depth for photosynthesis deepens with increasing temperature and light levels and more nutrients are available in surface waters. There is a smaller peak in phytoplankton levels in late summer and early fall (Earth Tech 1999).

Table 3-12: Major Species of Phytoplankton Found in the Gulf of Maine and Massachusetts Bay Area

Species Name	
Amphidinium crassum	*Leptocylindrus danicus*
Betonula confervaceae	*Leptocylindrus minimus*
Ceratium longpipes	*Porosira glacialis*
Chaetoceros sp.	*Rhizosolenia. faevoeuse*
Coscindodiscus sp.	*Rhizosolenia fragillissima*
Cylindrotheca closterium	*Skeletonema costatum*
Guinardia flaccida	*Thalassiosira sp.*

Source: NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999.

Zooplankton

A diverse zooplankton community comprising approximately 160 species, but dominated by three or four species of calanoid copepods, occurs in the Gulf of Maine and Massachusetts Bay area (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). Information about the specific composition of zooplankton populations in the Stellwagen Bank area is lacking. It is likely that the shelf community differs from those of surrounding waters, since water depth and the interrelated factors of temperature, circulation, and salinity are key factors in the distribution of zooplankton (Thurman 1988, cited in Earth Tech 1999). Massachusetts Bay is a highly productive zooplankton area because the counterclockwise currents in the Gulf of Maine bring zooplankton into the bay. Because both meroplankton and holoplankton are important components of the zooplankton population, the area is a critical habitat for the early life stages and food of commercial fishery species (Pett and McKay 1990, cited in Earth Tech 1999).

Table 3-13 presents the major species of zooplankton found in the Gulf of Maine and Massachusetts Bay (NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999). Unlike the case of phytoplankton, there is not a great deal of seasonal variation in the composition of species, although densities of species do change. The largest increase in zooplankton populations begins in March, coincident with the period of greatest abundance of phytoplankton, and peaks in May. The decrease in population densities during the summer is the result of both natural mortality and predation. There may be another smaller increase in zooplankton populations in fall, followed by another decrease in the winter months (Pett and McKay 1990, cited in Earth Tech 1999). Distribution of zooplankton also varies with depth, especially during summer stratification, which may be less pronounced in waters over the bank. Surface waters to 25 m are dominated by smaller copepods and the younger life stages of large copepod species; fish species eggs and larvae; and, at night, migrating copepods, euphausiids, and chaetognaths. At mid-depths of 25 to 100 m, the copepod *Calanus* dominates. At depths greater than 100 m, giant copepods, chaetognaths, and euphausiids are found (Pett and McKay 1990, cited in Earth Tech 1999).

Table 3-13: Major Species of Zooplankton Found in the Gulf of Maine and Massachusetts Bay Area

Species Group	Species
Amphipod	*Euthemisto sp.*
Chaetognath	*Eukronia sp.*
Chaetognath	*Sagitta elegans*
Chaetognath	*Sagitta lyra*
Cnidania	*Aurelia sp.*
Cnidaria	*Cyanea sp.*
Copepod	*Acartia sp.*
Copepod	*Anomalocera sp.*
Copepod	*Calanus finmarchicus*
Copepod	*Centropages typicus*
Copepod	*Euchaeta norvegica*
Copepod	*Metridia lucens*
Copepod	*Pseudocalanus minutus*
Copepod	*Temora longicornus*
Copepoda	*Acartia sp.*
Copepoda	*Calanus finmarchicus*
Copepoda	*Centropages typicus*
Copepoda	*Metridia lucens*
Ctenophore	*Pleurobrachia pileus*
Copepoda	*Pseudocalanus minutus*
Copepoda	*Temora longicornus*
Decapod shrimp	*Pasiphaea sp.*
Euphausiid	*Meganyctiphanes norvegica*
Euphausiid	*Thysanoessa sp.*
Pteropod mollusc	*Limacina retroversa*

Source: NOAA 1993; Pett and McKay 1990, cited in Earth Tech 1999.

3.4 SOCIOECONOMIC RESOURCES

The socioeconomic resources of the region include commercial fishing, commercial shipping and navigation, whale watching, recreational fishing, bird watching, boating, and diving. Each resource is discussed in more detail below.

Commercial Fishing

Commercial fishing, including groundfish, pelagic, and invertebrate fisheries, both historically and currently is the most economically important human activity in the productive waters of the Gulf of Maine, including Massachusetts Bay. Stellwagen Bank is an area of particular concentration for commercial fisheries, with more than 280 commercial vessels active in the area in 1990 (NOAA 1993, cited in Earth Tech 1999). Fish species of commercial importance are grouped in four categories: groundfish, pelagics, other finfish, and invertebrates. Table 3-14 shows the important commercial species in each of those groups, as well as the commercial value of landings of those species, according to 1990 statistics. Although most fish species are taken year-round, peak fishing intervals occur for most regulated species (see Table 3-15). Commercial bluefin tuna fishing represented 50 percent of the economic value of all fisheries in the Stellwagen Bank area in 1990, and the majority of the U.S. catch of this species is landed in Massachusetts coastal waters. After bluefin, the most valuable species in the Stellwagen area in terms of dollars are cod, yellowtail flounder, and pollock; in terms of poundage, dogfish, whiting, cod, and pollock are important (USGS/NOAA 1996, cited in Earth Tech 1999).

While more recent statistics were not available on the Stellwagen Bank area alone, information about commercial catches from Cape Hatteras to Nova Scotia indicate that during the period from 1994 to 1997, commercial value peaked in 1995 and in 1997 had increased by 37 million dollars for the entire region, representing only a 4 percent increase (NOAA 1998, cited in Earth Tech 1999). Therefore, the 1990 statistics are probably within 10 percent of current commercial value. In 1997, in the northeast as a whole, from Cape Hatteras to Nova Scotia, lobster was the number one revenue generator, followed by sea scallops, and along with squid and shrimp represented 31 percent of the catch since 1994. Principal pelagics represented 30 percent of the catch, and groundfish and flounder represented 36 percent of the catch (NOAA 1998, cited in Earth Tech 1999).

The fish species taken commercially are managed by the New England Fishery Management Council or the Mid-Atlantic Fishery Management Council through a number of fisheries management plans, including plans for the American lobster, the Atlantic sea scallop, the Atlantic salmon, the Atlantic mackerel, the squid, the butterfish, the Atlantic surf clam, the ocean quahog, the Atlantic bluefish, and the summer flounder. In addition, minimum catch sizes have been set for other species. Fishing is controlled by a complex set of regulations limiting entry and open access through limits on the number of permits issued and catch quotas. Changes in commercial fisheries that have taken place since the 1990 statistics were gathered include the implementation of fisheries management plans that restrict harvests of many species; changes in monitoring and reporting requirements; changes in mesh size; a 50 percent reduction in days at sea to reduce catch; permit and vessel buybacks; and the establishment of several closure areas, including the Massachusetts Bay and Midcoast closure areas, which include part of the Stellwagen Bank NMS (USGS/NOAA 1996; SSI 1999, cited in Earth Tech 1999). See Figure 3-3 for fishing hazards and restricted fishing areas, including the Jeffery's Juvenile area, which is restricted as a spawning area.

Table 3-14: Fish Species of Commercial Importance in Stellwagen Bank Area and Commercial Value of 1990 Landings

Groundfish Species ($5,979,134)	**Pelagic Fish ($7,964,716)**
Atlantic cod, *Gadus morhua*	Atlantic herring, *Clupea harengus*
Haddock, *Melanogrammus aeglefinus*	Atlantic mackerel, *Scomber scombrus*
Redfish (ocean perch, rosefish), *Sebastes spp.*	Butterfish, *Peprilus triacanthus*
Silver hake (whiting), *Merluccius bilinearis*	Bluefish (snapper), *Pomatomus saltatrix*
Red hake (squirrel hake), *Urophycis chuss*	Deep sea angler, *Ceratias holbolli*
Pollack, *Pollachius virens*	Menhaden (pogy), *Brevoortia tyrannus*
Yellowtail flounder, *Pleuronectes ferrugineus*	Bluefin tuna, *Thunnus thynnus*
Summer flounder, *Paralichthys dentatus*	Capelin, *Mallotus villosus*
America plaice (dab), *Hippoglossoides platessoides*	
Witch flounder, *Glyptocephalus cynoglossus*	**Other Finfish ($821,988)**
Winter flounder, *Pleuronectes americanus*	American shad, *Alosa sapidissima*
Scup (porgy), *Stenotomus chrysops*	Striped bass (rockfish), *Morone saxatilis*
Ocean pout (muttonfish), *Macozoarces americanus*	Spiny dogfish, *Squalus acanthias*
White hake, *Urophycis tenuis*	Skates, *Rajidae spp.*
Cusk, *Brosme*	Mako shark, *Isurus oxyrinchus*
Atlantic wolffish, *Anarhichas lupus*	Atlantic silverside (Capelin), *Menidia*
Fourspot flounder, *Paralichthys oblongus*	
Windowpane flounder (Sand Dab), *Scophthalmus aquosus*	**Invertebrates ($555,582)**
Greenland (Atlantic) halibut, *Reinhardtius hippoglossoides*	Short-finned squid, *Illex illecebrosus*
King whiting (kingfish), *Menticirrhus saxatilis*	Long-finned squid, *Loligo pealei*
Sculpins, *Myoxocephalus octodecimspinosus*	American lobster, *Homarus americanus*
Sea sturgeon, *Acipenser sturio*	Northern shrimp (pink shrimp), *Pandalus borealis*
Tautog (blackfish), *Tautoga onitis*	Surf clam, *Spisula solidissima*
Sand eel (sand lance), *Ammodytes americanus*	Ocean quahog, *Artica islandica*
American eel, *Anguilla rostrata*	Sea scallop, *Placopecten magellanicus*
Black sea bass, *Centropristis striata*	

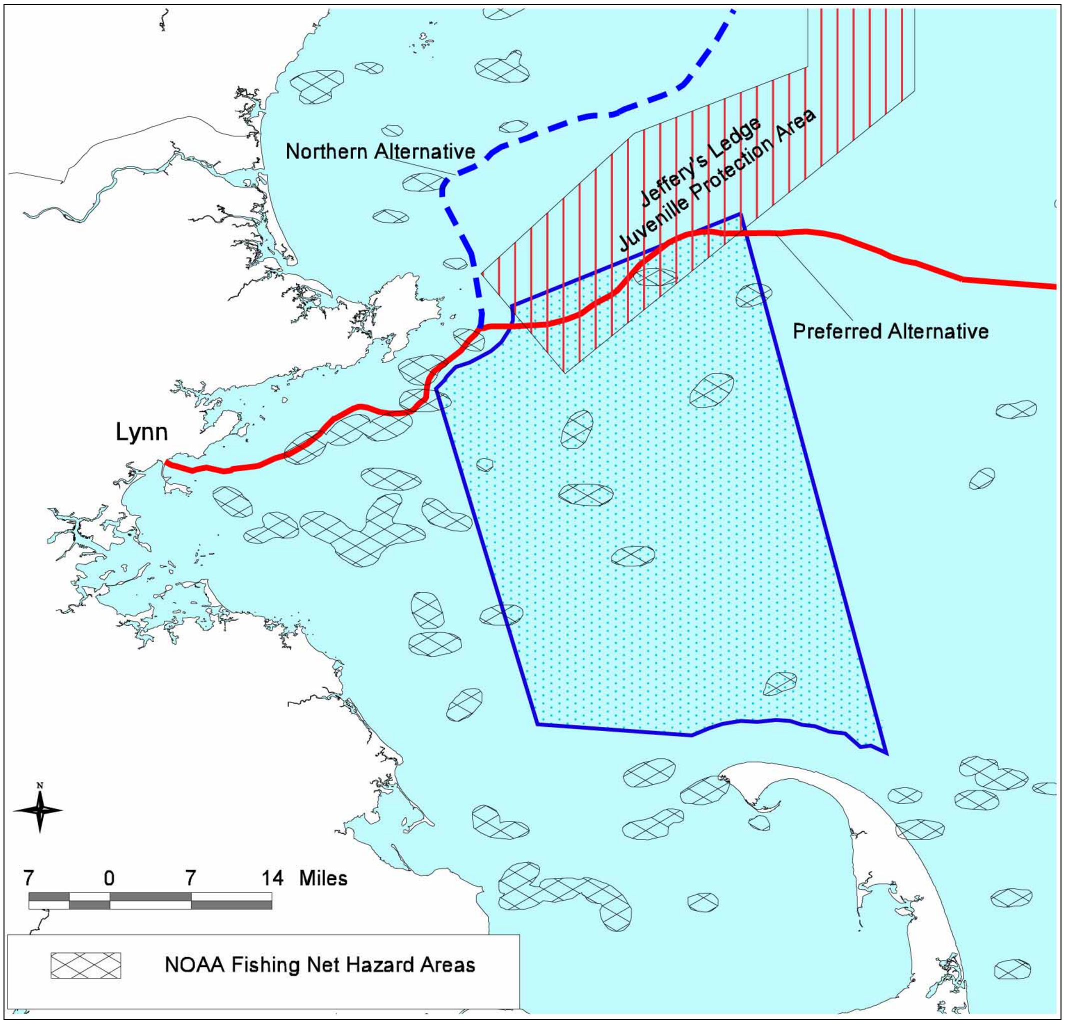
Source: NOAA 1993, cited in Earth Tech 1999.

Table 3-15: Peak Seasonal Fishing Intervals for Major Regulated Species in the Stellwagen Bank Area

January through March		**April through June**	
Winter flounder		Winter flounder	Witch flounder
Atlantic herring		Redfish	Atlantic cod
Northern shrimp		American plaice	
July through September		**October through December**	
Bluefin tuna	Redfish	Silver hake	White hake
Red hake	American plaice	Red hake	Winter flounder
Summer flounder	Witch flounder	Pollack	Atlantic herring
Striped bass	Bluefish	Atlantic mackerel	American lobster
		Butterfish	Sea scallop

Source: NOAA 1993, cited in Earth Tech 1999.

Figure 3-3: Massachusetts Bay Fishing Hazards and Restricted Fishing Areas (USGS 2000)



The major types of mobile commercial fishing gear used include otter trawls; purse and Scottish seines; and, occasionally, scallop and clam dredges. Static fishing gear includes sink gillnets, lobster pots, and longlines. With the exception of purse seines, which are set to catch pelagic fish species at or near the ocean surface, the gear can affect both ocean waters and the seabed. Otter trawls, the most common fishing gear, and Scottish seines are drawn along the seabed to catch bottom-dwelling fish species. Scallop and clam dredges harvest shellfish on or in the sea bed. Tub trawls are anchored or can drift in the water column and are used to catch groundfish. Sink gillnets can be set at any level within the water column. Hook and line are used for both groundfish and tuna. Rigid fish and lobster traps are used to harvest groundfish, lobsters, and crabs. In terms of commercial value, from 1994 to 1996 for the northeast fishery, pots and traps provided the largest amount of revenue, followed by bottom otter trawls and sea scallop dredges (NOAA 1998, cited in Earth Tech 1999).

Commercial Shipping and Navigation

Commercial shipping is also an important industry in the area. Heavily used vessel traffic lanes carry more than 2,700 commercial vessels through the Massachusetts Bay area to Boston each year (NOAA 1993, cited in Earth Tech 1999). There is an established Vessel Traffic Separation Scheme for boat traffic. About half the vessels carry liquid petroleum products, with the rest carrying bulk materials and automobiles. In addition, a small number of cruise ships and research and military vessels traverse the Gulf of Maine to Boston Harbor and Cape Cod. Vessel traffic exhibits no marked seasonal pattern.

Whale-Watching

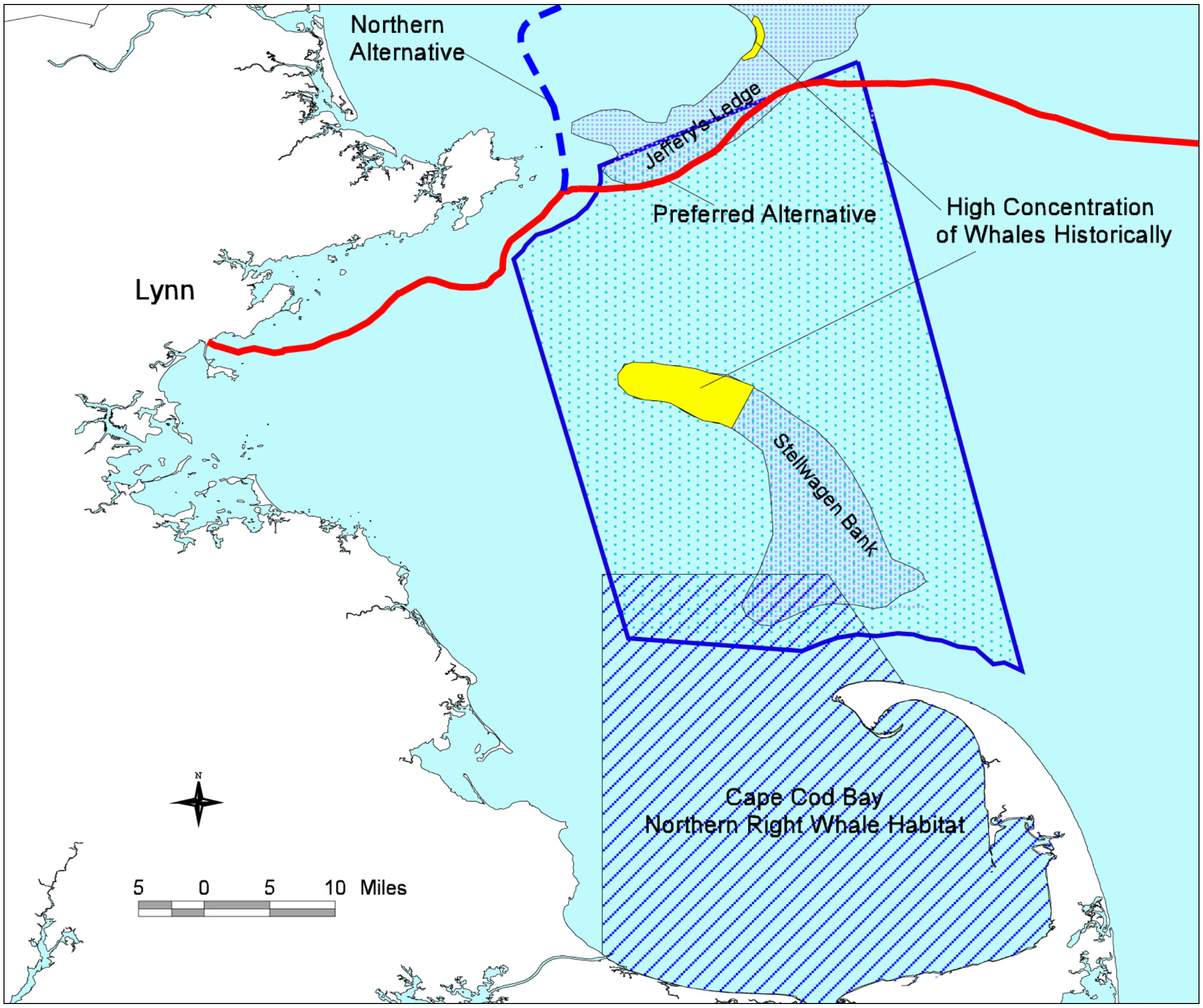
The whale-watching industry has grown steadily since its beginnings in Massachusetts in the late 1970s. Whale-watching trips provide recreational and educational opportunities and also can provide opportunities for marine bird watching (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). The Massachusetts area, from Gloucester to Provincetown, has been referred to as the “golden crescent” of whale watching (Rumage 1990, cited in Earth Tech 1999). The New England Whale-Watching Association has estimated that 48 percent of all whale-watching in the United States and 39 percent of all whale-watching activity worldwide take place in New England (NOAA 1996, cited in Earth Tech 1999). See Figure 3-4 for major whale-watching locations in and around Massachusetts Bay.

Whale-watching operations in the area are focused primarily on Stellwagen Bank and Jeffrey’s Ledge. Gloucester has four operations, Boston five, Salem one, Plymouth one, Barnstable one, and Provincetown four. Some operations in Gloucester and Provincetown have several boats. Farther north, Newburyport, Massachusetts; Portsmouth and Rye Harbor, New Hampshire; and Bar Harbor, Maine have one or more whale-watching operations (NOAA 1996, cited in Earth Tech 1999).

The whale-watching season usually begins in April, with about one trip daily through June. During those months, school groups make up the principal market. July and August make up the peak season, usually with two trips per boat per day. During that peak season, tourists are the principal market. During September and October, until Columbus Day, a daily trip on weekends is typical. In general, seasonal demand and varying weather conditions affect the number of trips (NOAA 1996, cited in Earth Tech 1999).

In addition to the commercial whale-watching vessels, numerous small, private boats follow the commercial boats to the whale-watching areas. The smaller boats are referred to as the “mosquito fleet” (NOAA 1996, cited in Earth Tech 1999). Whale-watching boats can carry from 40 passengers (a 50-foot boat) to almost 400 passengers (a 140-foot boat) and make from one to three trips per day. The industry, therefore, has a significant effect on the area’s economy. Revenues from commercial whale-watching were more than $20 million dollars for the two-year period from 1985 to 1986 and were more than $17 million in 1990 (NOAA 1993, cited in Earth Tech 1999).

Figure 3-4: Massachusetts Bay Whale-Watching Locations (USGS 2000)



Recreational Fishing

Before the mid-1970s, most recreational fishing was conducted in the nearshore waters inside the three-mile limit (U.S. territorial waters). After that time, groundfish declined in the nearshore area, and the market for bluefin tuna opened in Japan. Those two factors influenced an increase in the amount of recreational fishing taking place on Stellwagen Bank (NOAA 1993, cited in Earth Tech 1999).

Recreational fishing activities, including sport fishing, on Stellwagen Bank can be best described by the type of fishing vessels used. Those vessels include party boats, charter boats, and private rental boats. Targeted sport fishing species and their seasons include baitfish and sport fish (late May to September), groundfish (March to June), and tuna (June to early November). Recreational and tourism activity in the Stellwagen Bank area also includes operations of privately owned boats used for fishing or whale-watching and bird watching (Pett and McKay 1990; NOAA 1993, cited in Earth Tech 1999). Data from 1987 through 1989 on recreational fishing beyond the three-mile limit indicate that the following species are those most commonly caught (NOAA 1993, cited in Earth Tech 1999):

- Scup (Stenotomus chrysops)
- Bluefish (Pomatomus saltatrix)
- Atlantic Cod (Gadus morhua)
- Winter Flounder (Pleuronectes americanus)
- Atlantic Mackerel (Scomber scombrus)
- Pollock (Pollachius virens)
- Tautog (Tautoga onitis)
- Dogfish Sharks (Squalus acanthias)
- Summer Flounder (Paralichthys dentatus)

Sport fishing is also a major commercial operation in the area. Statewide, the industry was valued at $9.5 million in 1987 from charter boats and $167 million from private boat rentals. Recreational fishermen and tourists also spend significant tourism dollars that bolster the area's economy (Earth Tech 1999).

Bird Watching

Marine bird watching is a recreational activity in the Stellwagen Bank area that can be experienced in conjunction with whale-watching trips or sport fishing trips or carried out by interested individuals in privately owned boats. The ecotourism industry offers such options as the Center for Oceanic Research and Education's trips offshore during which bird experts assist with sightings and offer expertise in the identification of numerous species of birds. Cold-water seabirds of the Gulf of Maine and, at times, subtropical and Gulf Stream species can be observed (NOAA 1996; CORE 1999, cited in Earth Tech 1999).

Boating

Recreational boating is very popular in the Stellwagen Bank area, as well as in the area between the bank and the Cape Ann and Boston region. The area has numerous marinas at which a variety of recreational boats, both power and sail, are moored seasonally or at which transient moorings or berths are available. The proximity of the Stellwagen Bank to those areas allows day trips or through passage to popular destinations at the Isles of Shoals, New Hampshire and Maine; coastal New Hampshire; and Maine (Earth Tech 1999).

Diving

Recreational diving occurs infrequently in the Stellwagen Bank area. Most diving in the offshore area is anticipated to occur in the vicinity of reported wrecks (Earth Tech 1999).

3.5 CULTURAL AND HISTORICAL RESOURCES

During the past five centuries, boats and ships have been used over the project area for a variety of reasons, including exploration, transportation, fishing, and warfare. Historical vessel traffic occurred over the Stellwagen Bank area in three basic patterns: vessel traffic to and from Massachusetts Bay ports; increased vessel traffic bound for ports beyond Massachusetts Bay after the opening of the Cape Cod Canal in 1914; and vessel traffic related to the Massachusetts Bay fishing fleet (USGS/NOAA 1996, cited in Earth Tech 1999).

Over time, some of the vessels were lost, creating unique sites that would be considered historically and archaeologically significant by federal and state standards, since they may contain information about America's past that cannot be found elsewhere (Riess 2000). The National Ocean Service's Automated Wreck and Obstruction Information System has placed numerous shipwrecks, mainly fishing vessels, in the area. Records of the Historic Maritime Group of New England also have identified possible shipwreck areas in the vicinity of the Stellwagen Bank NMS. An aircraft crash site also may be located in the area (Mastone 1990; NOAA 1993; USGS/NOAA 1996, cited in Earth Tech 1999).

An archaeological survey (magnetometer survey) was conducted in February 2000 to determine whether any cultural or historical resources are located in the vicinity of the proposed cable route. The survey, prepared by Dr. Warren Reiss of the Darling Marine Center, University of Maine, included both a study of historical records and an analysis of data from remote-sensing searches.

The study of historical records included a search for information about lost vessels in published and unpublished secondary sources and limited primary archival material. It included the entire sea floor in the northern section of the Stellwagen Bank NMS within one mile of the planned cable route, and addressed resources more than 50 years old. Table 3-16 presents the results of the study of historical records and secondary sources (Riess 2000).

Table 3-16: Table of Shipwrecks Located During Background Research

Name	Date	Location	Wreck Notes
Erfprins	11/25/1783	24 mi off Cape Cod	Foundered
Shylock	12/1/1860	35 mi east of Cape Ann	Abandoned
Frank A. Palmer	12/17/1902	Thatchers Island, Rockport	Collided with *Louise B. Crary*
Louise B. Crary	12/17/1902	Northern edge of Stellwagen Bank NMS	Collided with *Frank A. Palmer*
Nataile Hammond	7/29/1937	Northeast sector of Stellwagen Bank	All crew saved
Restless	10/4/1942	Stellwagen Bank	Burned
Unknown	1/1/1949	Northern Stellwagen Bank NMS	
Alden	2/22/1957	Stellwagen Bank area – 8 mi off Thatcher's Buoy	Fire

Source: Riess 2000.

The remote-sensing component of the archaeological survey included the examination of a 200-foot-wide corridor centered on the proposed cable route. Several instruments, including a navigation system, a magnetometer, side-scan sonar, and a bathymeter were used in the effort. The data collected were examined in several different ways to identify possible magnetic anomalies and sonar targets. No sites were found within 100 feet of either side of the centerline of the proposed cable route throughout the Stellwagen Bank NMS.

The survey examined only the Preferred Alternative route through the Stellwagen Bank NMS and did not include a detailed examination of the Northern Alternative route. Therefore, only data from secondary sources were examined for the Northern Alternative. On the basis of such data, it was determined that known and potential cultural and historical resources occur in proximity to the Northern Alternative route. The Northern Alternative crosses areas than can serve as navigation routes to and from the city of Portland, Maine. Navigation charts indicate wreck locations in the vicinity of Jeffrey's Ledge and approach areas to the ledge. Natural and man-made seafloor obstructions along that route and wrecks in proximity to it were identified from Admiralty charts (Earth Tech 1999).

Even though no recorded prehistoric cultural resources, sites, or artifacts have been identified to date, the potential that they exist should be considered. Periodic recovery of remains such as parts of skeletons of mammoths and mastodons by fishermen does indicate that environmental conditions once supported such megafauna (NOAA 1993, cited in Earth Tech 1999).

4.0 ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION AND ALTERNATIVES

This section describes in detail the potential effects of the alternatives considered in this EA. Effects are organized by the alternatives discussed in Section 2 and are described for the specific resource areas that were discussed in Section 3. Effects of the cable route, cable specifications, cable installation, and operations and maintenance are analyzed.

The potential effects of the project on environmental resources and marine activities include temporary interference with navigation, fishing, and other marine activities and disturbance of marine resources. Disturbances would be localized along the proposed cable routes, and potential effects are expected to occur only during installation of the cable (Earth Tech 1999).

Once the cable has been installed, operations and maintenance activities are not expected to be required within the sanctuary. The fault rate assumption by the applicant's maintenance providers for the entire 12,124 km Hibernia Project is from 1.58 to 2.58 faults per year. Application of the high-end figure yields an expected number of approximately 0.005 faults along the cable segment within the Stellwagen Bank NMS, or one fault every 200 years (360networks, inc. 2000a).

The primary threat to submarine cables is bottom fishing, and the fault rate considers both buried and unburied cables, although the majority of faults affect unburied cable. The applicant therefore considers the quoted fault rate for the Stellwagen Bank NMS to be a conservative estimate (360networks, inc. 2000b). The likelihood of a need for any operations and maintenance activities occurring within the Stellwagen Bank NMS during the expected life of the cable is very remote. Potential environmental effects of operations and maintenance activities therefore are discussed only briefly.

4.1 PREFERRED ALTERNATIVE

This section describes the environmental impacts of the Preferred Alternative to the water; geologic; biological; cultural and historical; and socioeconomic resources of the Stellwagen Bank NMS.

4.1.1 Water Resources

Cable Route

As discussed in Section 3, the proposed route avoids areas of known contamination. Therefore, it is not expected that significantly contaminated soils would be encountered along the proposed route, and effects on water resources caused by the route selection would be minimal.

Cable Specifications

The cable is constructed of optical fibers surrounded by a copper conductor and steel strength members and contained within a polyethylene tube that should prevent any leaching of metals into the environment. The cable is armored by steel wires and coated with a compound produced from pine tar. The compound contains no petroleum-based products and does not decompose or break down. Therefore, once installed, the buried cable would not produce any subsequent alterations in suspended sediment or water turbidity levels. No long-term effects on water quality as a result of the degradation of the cable system are anticipated.

Cable Installation

Temporary, minor, local effects on water quality from discharges of sanitary waste, bilge water, minor fuel oil spills, and general debris could occur because of the operation of ships during installation of the cable. Installation of the cable through the Stellwagen Bank NMS would take less than two days. It is not expected that it would be necessary to discharge sanitary waste from ships into the ocean during such a short time. It is possible that normal ship operations could cause the discharge of minor amounts of petroleum products to the water during such a period. However, vessels would operate in accordance with the regulations of the U.S. Coast Guard (USCG) and other applicable regulations, in a manner similar to the operations of any other commercial vessel in U.S. waters.

The temporary disturbance of sediments caused by installation of the cable should have no significant effect on water quality and should cause no harm to marine biota from increased levels of toxicants. Because of the use of sea plow technology, rather than the more traditional cut-and-cover technology, disturbance of the sea bed and any potentially contaminated sediments would be minimal and temporary. Activities typically associated with dredging operations, such as suspension, side-casting or permanent removal of sediment, would be avoided. The slow speed of a ship plowing and installing cable would minimize sediment disturbance further and prevent potential ship collisions that could cause contaminants such as petroleum products to enter ocean waters.

Operation and Maintenance

Once the cable has been installed, operation of the cable should not have any effects on water quality. In the unlikely event of a cable fault (see the discussion of probability set forth above), repair operations would necessitate unburying the cable in the vicinity of the damage and bringing it to the surface for repair. After repair, the cable would be reburied by a remotely operated vehicle. Section 2 of this document presents a more detailed description of cable repair activities. Repair operations would cause temporary sediment disturbance of sediment, suspension of sediment in the water column, and disturbance of benthic communities.

4.1.2 Geologic Resources

Cable Route

Since regulations prohibit drilling and dredging activities within the boundaries of the sanctuary, there would be no effect on the extraction of mineral or gas resources. In addition, the lack of historical exploratory drilling or interest on the part of oil and gas companies indicate that it is unlikely that any interest in such activities be undertaken during the life of the project.

The proposed route avoids areas of known contamination, such as those discussed in Section 3. Therefore, it is not expected that significantly contaminated soils will be encountered along the proposed route; effects on geologic resources as a result of route selection would be minimal.

Review of the data obtained by side-scan sonar and subbottom profiler for the Preferred Alternative route did not reveal any bed forms indicated by current, such as megaripples, sand waves, or current scour. Therefore, no long-term hydrographic events are expected to affect the cable once installation has been completed. Normal seasonal currents currently affect the sediments of the sea floor, but those currents have shown no mass removal of sediment that would even suggest the possibility that the cable might be exposed. The 19.49 km of cable in Stellwagen Bank NMS would be placed at a depth of 60 m, well below any wave effects in the area. No significant events, such as hurricanes or 100-year storms, should affect the sediments on the sea floor in a manner that would expose the cable (360networks, inc. 2000a).

For the Preferred Alternative route, the cable would be buried in the softest bottom types to avoid unnecessary effects on the environment. Table 4-1 shows bottom types affected by length and percentage of the total Preferred Alternative route.

Table 4-1: Bottom Types Along the Preferred Alternative Route

Bottom Type	Length of Preferred Route		Segment within SBNMS	
	Length (km)	Percent	Length (km)	Percent
Gravel (Mixed Course)	18.8	16	3	14
Sand	19.3	17	7.291	35
Mud	40.2	35	1	5
Mud (silt/clay)	37	32	9.5	46
Total	**115.3**	**100**	**20.791**	**100**

Source: Seafloor Surveys International, Inc. 1999. Note that the total length listed reflects a small segment where the route would briefly leave the Sanctuary and then re-renter. When not included, the total length of the Preferred Alternative route would be 19.49 km.

Cable Specifications

The cable is constructed of optical fibers surrounded by a copper conductor and steel strength members and is to be contained within a polyethylene tube that should prevent any leaching of metals into the environment. The cable is armored by steel wires and coated by a compound produced from pine tar. The compound contains no petroleum-based products and does not decompose or break down. Therefore, no long-term effects on to sediment quality resulting from the degradation of the cable system are anticipated.

Cable Installation

The project would involve the temporary disturbance of sediments on the ocean bottom to plow a 1 m wide by 1.5 m deep wedge in the sediments to bury the cable. The width of the sea plow mechanism is 4.6 m, including the skids. The skids generally “float” on the surface of the sea bed, rather than disturbing it. During plowing operations, only the plowshare itself impacts the sea bed. Only during times when the plowshare is not in operation would the entire sea plow rest on the sea bed. Therefore, during installation the width of the disturbed area would be the width of the plowshare (1.5 m deep and 1.0 m wide, by 19.5 km, or a total of approximately 4.8 acres of disturbed sea bed) (360networks, inc. 2000a).

Installation of the cable should cause only minor and localized temporary suspension of sediment along the cable route, since the ship towing the plow would travel at a speed of only 0.5 to 1 knot and the area that would be disturbed is narrow. The sediment that would be disturbed would be displaced sideways and upward but would fall back into the trench immediately after the plow passes and the cable is inserted into the trench. As the sediments are disturbed, any contaminants bound to the sediments could be resuspended temporarily. The temporary disturbance of sediments caused by installation of the cable should have no potential significant effect on sediment or water quality and should cause no harm to marine biota as the result of increased levels of toxicants.

Operation and Maintenance

A review of the detailed marine surveys of the project corridor indicates that no long-term hydrographic events would affect the cable once installation has been completed. The normal seasonal currents that currently affect sediments of the sea floor have shown no mass removal of sediment that would suggest that the cable might become exposed. Significant events, such as hurricanes or 100-year storms, should not affect the sea floor sediments in a manner that would expose the cable.

The storm of record in the area is the Halloween Storm of 1991. Examination of bathymetric charts from both before and after that storm indicates that the sea floor did not change to any significant degree. The depth of water, coupled with the depth at which the cable will be buried, should ensure that the cable would remain buried under such conditions.

4.1.3 Biological Resources

The potential effects of the Preferred Alternative on biological resources in the vicinity of the project area are described below. The resources discussed correspond to those presented in Section 3 and include fish; benthic communities; marine mammals, reptiles, birds; and plankton. The effects on each resource are presented as above, by cable route, specifications, installation, and operations and maintenance.

4.1.3.1 Fish

Cable Route

Demersal fish present that inhabit the cable route lay their eggs in the fall or early winter, and hatching usually occurs before spring. Installation of the cable on the U.S. portion of the route is expected to take place spring or summer 2000, after the eggs have hatched, thereby eliminating any direct effects, such as displacement of eggs.

Cable Specifications

Once installed, the buried cable will have no effect on fish species in the area.

Cable Installation

The habitat of both eggs and adults of the species of demersal fish found in the area would be disturbed temporarily during the plowing of the 1 m wide by 1.5 m deep wedge in the sediments to bury the cable. The result should be only minor and temporary disturbance of sediment and any bottom-dwelling fish or the eggs of those fish along the route. The sediment that would be disturbed would be displaced sideways and upward, but would fall back into the trench immediately after the plow passes and the cable is inserted into the trench. The alteration of other aspects of the habitat of demersal fish species, such as loss of prey, would be local and temporary and is not expected to have any measurable effect on populations of demersal fish species. Temporary displacement of some fish from the immediate vicinity (that is, tens of feet) of the cable route would occur during operation of the plow. Those impacts also would be of a temporary and local nature.

Pelagic fish should not be affected significantly by installation of the cable. Installation of the cable would take less than two days. It is not expected that any minor pollution effects from the operations of ships would affect those fish species.

Operation and Maintenance

Because the cable is buried permanently, the cable itself, as well as operation of the cable, would have no long-term effects on demersal or pelagic fish species, their reproduction, or their habitat. In the unlikely event that maintenance would be required, repair operations would necessitate unburying the cable in the vicinity of the damage and bringing it to the surface for repair. After repair, the cable would be reburied using a remotely operated vehicle. Repair operations would cause temporary sediment disturbance and sediment suspension in the water column.

4.1.3.2 Benthic Communities

Cable Route

Because of the geologic characteristics along the Preferred Alternative route, the benthic communities present are those associated with soft-bottom areas.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed it would not have effects on benthic organisms present in the project area.

Cable Installation

Environmental effects on benthic communities in Stellwagen Bank NMS would result from operation of the plow. The project would involve the temporary disturbance of ocean bottom sediments while plowing a 1 m wide by 1.5 m deep wedge in the sediments to bury the cable. The width of the plow is 4.6 m, including the skids. The skids “float” on the surface of the sea bed, rather that disturbing it. Therefore, the width of the disturbed area would be the width of the plowshare (1.5 m deep and 1.0 m wide, by 19.5 km, or a total of approximately 4.8 acres of disturbed sea bed) (360networks, inc. 2000a).

During installation of the cable, sedentary and slow-moving benthic organisms would be injured and killed. The plow blade may contact such organisms, and the wheels of the plow may crush some individuals. More mobile benthic species, such as groundfish, lobsters, and crabs, would be expected to avoid direct contact by moving out of the way of the sea plow (NMFS 2000, Earth Tech 1999).

Because the amount of disturbance of soil required for installation is minimal and the disturbed area would be restored immediately to preinstallation conditions, effects on the marine environment would be minimal. In addition, installation of the cable progresses slowly, at a rate of approximately 0.5-1.0 knot, thereby limiting the potential that the plow would affect benthic habitats adversely. Given the narrow area of temporary disturbance of sediment, it is anticipated that much of the benthic infauna and epifauna would recolonize the area in which the cable was laid within a matter of weeks or months. In some cases, recolonization would not occur until the next spawning season.

Operation and Maintenance

It is not expected that, after installation of the cable, the project will affect marine resources or activities because the cable would be buried to a depth of approximately 1.5 m beneath the sea bed. The location of the route also would be charted to alert mariners to the presence of the cable.

Operation of the cable should not have any effects on the benthic community. In the unlikely event of a cable fault, repair operations would necessitate unburying the cable in the vicinity of the damage and bringing it to the surface for repair. After repair, the cable would be reburied by a remotely operated vehicle. Repair operations would cause temporary disturbance of sediment, suspension of sediment in the water column, and disturbance of benthic communities.

4.1.3.3 Marine Mammals

Potential effects on marine mammals include ship strikes during installation, entanglements during deployment of the cable, and disturbances caused by induced electrical fields (NMFS 2000; 360networks,inc. 2000b).

Cable Route

The Stellwagen Bank NMS provides important feeding habitat for a number of marine mammal species. Marine mammals are also known to feed and nurse in the project area and to migrate through it.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would not have effects on any marine mammals in the project area.

Cable Installation

Any effects from the cable-laying ship likely would not differ from those of other vessel traffic common throughout the region. It is possible that the cable-laying ship might collide with a marine mammal along the cable route or that a marine mammal might become entangled in the cable during installation. However, it is likely that the speed of the ship during cable-laying activities would be slower than that of migrating whales or seals. NMFS concluded that, as long the speed of the cable ship during installation was no more than 1.0 knot, the Preferred Alternative would not be likely to adversely affect endangered whales that may be present in the project area (NMFS 2000).

The potential for disturbance of marine mammals as a result of induced electrical fields was evaluated and found to be insignificant. The electrical field induced around the cable is proportional to the rate of change of current flowing through it. Since the cable carries direct current (DC) only, there is no rate of change of current, so there is no electric field around the cable, except when the cable is powered up or down. The power-up procedure typically takes several minutes, so the induced electric field is negligible.

For the Hibernia system, the current is 0.4 amplitudes (amp) for the initial system. Ultimately, it would not exceed 0.7 amp, which is less than many household appliances (for example, a typical toaster draws 12 amps).

The intensity of the magnetic field at a distance of 1 m from the cable with a 0.7 amp current will be 0.14 micro-tesla. The intensity of the naturally occurring magnetic field at the surface of the earth ranges from 300 micro-teslas at the equator to 600 micro-teslas at the poles. Therefore, the magnetic field at a distance of 1 m from the cable is more than 2,000 times less intense than the naturally occurring magnetic field of the earth (360networks 2000b).

Operation and Maintenance

In the unlikely event of a cable fault, it might be necessary to apply an electroding signal to the cable to locate the fault. If an electroding signal were applied to the cable, a low-level AC signal would be generated, with a frequency in the range of 15 to 25 hertz (Hz) for the short time period necessary to locate the fault.

After the cable has been installed, entanglements of marine mammals would be highly unlikely because the cable is to be buried along its entire proposed route. NMFS concluded that the Preferred Alternative would not be likely to adversely affect endangered whales that may be present in the project area if the cable is to be buried to a depth of 1.5 m beneath the sea bed. NMFS also recommended that post-deployment surveys be conducted within 30 days of the installation of the cable, and again four years after installation, to document that target depths of deployment were reached (NMFS 2000).

4.1.3.4 Marine Reptiles

Marine reptiles could be affected by the Preferred Alternative in a number of ways. Ship strikes could occur during installation of the cable and entanglements could take place, both during deployment of the cable and after installation, if any portion of the cable that is unburied (NMFS 2000).

Cable Route

The Stellwagen Bank NMS provides important feeding habitat for a number of species of marine reptiles. Marine reptiles are also known to feed and nurse in the project area and to migrate through it.

Cable Specifications

As the cable would be buried at a depth of 1.5 m, once installed it would not have effects on marine reptiles in the project area.

Cable Installation

No temporary or permanent effects on marine reptile populations are likely or expected as a result of installation of the fiber-optic cable, which would not affect habitat of those populations. There is a slight potential that marine reptiles might become entangled in the ship lines during installation of the cable, or collide with the vessel performing the installation. However, the lines are maintained fairly taut and entanglement is unlikely. The potential for ship strikes and entanglements during deployment would also be reduced by the slow speed of the ship during installation. It is proposed that the deployment speed would be between 0.5 and 1.0 knot.

Operation and Maintenance

No temporary or permanent effects on marine reptile populations are likely or expected as a result of operation of the fiber-optic cable, which would not affect the habitat of those populations.

After installation of the cable, the potential for entanglements would be eliminated because the cable is to be buried along its entire proposed route. It is recommended that post-deployment surveys be conducted within 30 days after installation of the cable, and again four years after installation, to document that target depths of deployment were reached (NMFS 2000).

4.1.3.5 Marine Birds

Cable Route

The Stellwagen Bank NMS provides important feeding habitat for a number of species of marine birds. However, no effects on the feeding habitat of those species would be expected under the Preferred Alternative.

Cable Specifications

Since the cable is to be buried at a depth of 1.5 m, once installed, it would not have any effects on marine birds in the project area.

Cable Installation

No permanent effects on populations of marine birds are likely or expected as a result of installation of the fiber-optic cable. The cable is to be installed at sufficient depth that the temporary disturbance would not influence the feeding activities of either surface-feeding or diving bird species, in terms of both their spatial feeding area and their prey. Many such birds are adapted to frequenting areas used by fishing and other vessels. The presence of additional vessels during the short installation period therefore would not have a negative effect on their abundance.

There would be no temporary or permanent effects on the one federally listed endangered bird species, the Roseate tern. The recovery plan for the tern focuses on protecting breeding colonies, but availability of prey may limit population recovery by the species. The proposed project is not expected to have an effect on the availability of prey, and therefore would have no effect on the species. However, if the cable were to be installed during the months of August or September, which is the period during which the Roseate tern prepares for migration, the FWS must be advised (FWS 1999).

No mitigation measures are necessary because there will be no temporary or permanent effects on marine birds as a result of installation of the fiber-optic cable in the Stellwagen Bank area.

Operation and Maintenance

No permanent effects on marine bird populations are likely or expected as a result of operation or maintenance of the fiber-optic cable.

4.1.3.6 Plankton

Cable Route

The Stellwagen Bank NMS provides important habitat for a number of species of zooplankton and phytoplankton. However, no effects on the habitat of those species would be expected under the Preferred Alternative.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would have no effects on any species of plankton in the project area.

Cable Installation

No temporary or permanent effects on populations of phytoplankton or zooplankton are likely or expected as a result of installation of the fiber-optic cable. The cable is to be installed at sufficient depth that the temporary disturbance will not influence the distribution or abundance of plankton. No mitigation measures are necessary, since there will be no temporary or permanent effects on plankton as a result of installation of the fiber-optic cable in the Stellwagen Bank NMS.

Operation and Maintenance

No temporary or permanent effects on populations of phytoplankton or zooplankton are likely or expected as a result of operation and maintenance of the fiber-optic cable. No mitigation measures are necessary, since there will be no temporary or permanent effects on plankton as a result of operation and maintenance of the fiber-optic cable in the Stellwagen Bank NMS.

4.1.4 Socioeconomic Resources

The potential effects of the Preferred Alternative on the socioeconomic resources of the region are described below. The resources described correspond to those presented in Section 3: commercial fishing, commercial shipping and navigation, whale watching, recreational fishing, bird watching, boating, and diving.

4.1.4.1 Commercial Fishing

Cable Route

Under the project, there is no plan to request an "exclusion zone" around the cable in which use of traditional fishing methods (including trawls, long lines, gillnets, and pots) would be restricted. The cable route would be marked on marine charts, and fishermen would be warned to avoid the cable (360networks, inc. 2000a).

Cable Specifications

To avoid interference with important commercial fisheries and fishing gear, the cable would be armored for protection against breakage and buried to 1.5 m. Since the cable would be buried to the 1,500 m contour for protection against existing and future fishing activity, it would not be a significant threat to boat anchoring or use of most fishing gear, such as bottom-set long line, gillnets, and lobster pots and traps.

The proposed cable would be protected from contact with fishing gear by armoring and burial in the sea bed. Further, fishermen would not be held liable if they damage the cable (whether the damage occurs during the cable's operational life or after abandonment) while using traditional fishing methods and gear, unless such damage is intentional or egregious. In addition, should a fisherman's gear become snagged on the cable and be sacrificed, the applicant would reimburse the fisherman for the gear, provided that timely notice is given and that appropriate evidence is provided to show that the gear was sacrificed to avoid further damage to the cable (Earth Tech 1999).

Cable Installation

During installation of the cable through the Stellwagen Bank NMS, the applicant would take a number of actions to ensure that commercial fishing vessels, as well as other users of the sanctuary are fully aware of the installation. Such actions include:

- Deploy patrol vessels in high-traffic areas
- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners
- Air VHF broadcasts during installation period
- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

If NOAA approves an authorization and a special use permit for the Preferred Alternative, the applicant hopes to begin installation in June 2000 to accommodate fisheries by avoiding the main lobster season (360networks, inc. 2000a).

The installation of the cable line could affect fishing gear used in the area's commercial fisheries. Installation itself would take less than two days, so it should not interfere significantly with active fishery operations. Pelagic fisheries along the cable route that could be affected by the scheduling of the installation are active primarily from May through December. There is a remote potential for fishing boats to collide with the installation vessel.

As a mitigation measure, fishermen would be notified before installation begins to avoid damage to their gear during the installation. To do so, liaisons with the fisheries associations would be established to aid in communication with the fishing industry. During the installation period, the installation vessel would conform to appropriate rules of navigation to avoid collisions with fishing vessels.

Operation and Maintenance

Bottom-trawling is the fishing method most likely to be affected by the cable, because its use is widespread and it entails a high level of effort. Further, the nature of trawling gear entails a risk of entanglement, and the method involves penetration of the sea bed. Trawling gear penetrates, on average, 5 to 20 cm into the ocean bottom, and can be up to 55 m in width, affecting a large area. Usually tows are conducted at known productive fishing grounds that have been charted, and follow a narrow-range depth contour along the prevailing current pattern. Except during times of regulatory closures, trawl fishing is especially heavy on Jeffrey's Ledge, Stellwagen Bank, and Georges Bank, but it occurs in all areas of the central Gulf of Maine at some time each year.

4.1.4.2 Commercial Shipping and Navigation

Cable Route

While commercial shipping does take place in the vicinity of the Stellwagen Bank NMS, the Preferred Alternative route is expected to have no significant effect on commercial shipping because the route lies well north of established commercial shipping lanes.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would not have any effects on commercial shipping activities in the project area.

Cable Installation

No significant effects on commercial shipping are expected. The installation of the cable would take place over a period of less than two days and should not interfere with commercial shipping lanes.

While oil spills that result from collisions of vessels are always a threat, the implementation of the Vessel Traffic Separation Scheme has minimized the potential for such collisions. Of 105 vessel casualties in the period from 1984 through1988, 93 percent involved fishing vessels, and only two (less than two percent) involved commercial shipping vessels (NOAA 1993, cited in Earth Tech 1999). Given the volume of commercial ship traffic in the area, there is little potential for collisions in general, and the prospect of a significant spill caused by collisions between usual traffic and the cable installation vessel during the cable installation period is even more remote.

During installation of the cable in the Stellwagen Bank NMS, the applicant would take a number of actions to ensure that commercial shipping organizations are fully aware of the installation. Such actions will include:

- Deploy patrol vessels in high-traffic areas
- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners
- Air VHF broadcasts during installation period
- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

To maintain the security of the cable-laying operation at the stern of the ship, it is possible that commercial vessels may be hired to prevent other boats from intruding into the area. Otherwise, cable-laying is a specialized field, and it is unlikely that the local labor force would be used. Similarly, the cable-laying ship is self-contained; therefore, ancillary facilities and support for a work force, such as temporary housing and locally supplied food and clothing, are not needed.

All appropriate navigation regulations and precautions would be followed to ensure that commercial vessels are not impeded during the short period of cable installation.

Operation and Maintenance

Operation of the cable would have no effect on commercial vessels because the cable is to be buried beneath the sea bed. Performance of maintenance activities would be preceded by notification of commercial shipping industries.

4.1.4.3 Whale-Watching

Cable Route

The Stellwagen Bank NMS provides important habitat for a number of species of whales. Consequently, vessels of the whale-watching industry frequently visit the sanctuary. However, the Preferred Alternative route lies well north of the sites of most whale-watching operations in the Stellwagen Bank NMS, and is therefore expected to have no effect on the whale-watching industry.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would have no effect on the whale-watching industry in the project area.

Cable Installation

Installation of the cable is not expected to have any significant effect on whale-watching in the sanctuary, even if installation takes place in the primary whale-watching season, from May through July. In areas in which marine activity is heavy, it is possible to install a cable by working closely with other mariners and requesting a small (2-mile) moving corridor around the cable ship in which ship traffic is restricted.

Operation and Maintenance

Operation of the cable is expected to have no effect on the whale-watching industry. In the unlikely event that cable maintenance becomes necessary, the performance of maintenance activities would be preceded by notification to all mariners.

4.1.4.4 Recreational Fishing

Cable Route

The applicant does not intend to request a widespread fishing exclusion zone around the cable, and the cable would not interfere with usual fishing practices because it would be buried along its entire route through the Stellwagen Bank NMS (360networks, inc. 2000a).

Cable Specifications

The cable would be armored for protection against breakage and buried deeply. Since the cable would be buried to the 1,500 m contour for protection against existing and future fishing activity, it would not be a significant threat to boat anchoring and use of most fishing gear.

The proposed cable would be protected from contact with fishing gear by armoring and burial in the sea bed. Further, fishermen would not be held liable if they damage the cable (whether the damage occurs during the cable's operational life or after abandonment) while using traditional fishing methods and gear, unless such damage is intentional or egregious. In addition, should a fisherman's gear become snagged on the cable and be sacrificed, the applicant would reimburse the fisherman for the gear, provided that timely notice is given and that appropriate evidence is provided to show that the gear was sacrificed to avoid further damage to the cable (Earth Tech 1999).

Cable Installation

The installation and operation of the cable are expected to have no significant effect on recreational fishing activities. All appropriate navigation regulations and precautions would be followed to ensure that recreational fishery vessels are not impeded during the short period of cable installation.

During installation, the applicant would take a number of actions to ensure that operators of recreational fishing vessels, as well as other users of the sanctuary, are fully aware of the installation. Such actions would include:

- Deploy patrol vessels in high-traffic areas

- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners
- Air VHF broadcasts during installation period
- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

If NOAA approves an authorization and a special use permit for the Preferred Alternative, the applicant hopes to begin installation in June 2000 to accommodate fisheries by avoiding the primary lobster season (360networks, inc. 2000a).

Operation and Maintenance

Operation of the cable would have no effect on recreational fishing vessels because the cable would be buried in the sea bed. Performance of maintenance activities would be preceded by notification of the operators of recreational fishing vessels, as discussed above.

4.1.4.5 Bird Watching, Recreational Boating, and Diving

Cable Route

The Stellwagen Bank NMS is an important site for participation in a number of recreational activities, including bird watching, recreational boating, and diving. The Preferred Alternative route is expected to have no effect on such activities.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would have no effect on any recreational activities undertaken in the project area.

Cable Installation

Installation of the cable is not expected to have any significant effect on recreational activities in the sanctuary. In areas that are heavily used for such activities, it is possible to install a cable by working closely with other mariners and requesting a small (2 mi) moving corridor around the cable ship in which ship traffic is restricted. The restriction could affect recreational activities for a day or two as the cable is installed in the vicinity of such activities. Some temporary loss of boating area in the vicinity of the cable-laying vessel would be necessary to secure the umbilical and equipment towed behind the ship. The applicant would work with the boating community to keep mariners informed of the schedule for cable-laying operations.

Operation and Maintenance

Operation of the cable is expected to have no effect on recreational activities. In the unlikely event that maintenance of the cable becomes necessary, the performance of maintenance activities would be preceded by notification of other mariners, as discussed above.

4.1.5 Cultural and Historical Resources

Cable Route

During the planning process, Dr. Warren Riess conducted a study of historical records and secondary sources to identify known historic maritime cultural resources in the vicinity of the Preferred Alternative route (Reiss 2000). Dr. Riess and Ocean Surveys, Inc. also completed a survey by remote sensor of the possible impact area and analyzed the resultant data against data from a side-scan sonar survey previously acquired by the applicant for geophysical planning. The study found no cultural or historical resources located within 100 ft of either side of the centerline of the proposed cable route.

The study of historical resources conducted by Dr. Reiss did identify several shipwrecks in the region, although none iare located within the 200 ft wide corridor centered on the proposed cable route. Only if the installation of the cable strays outside the 200 ft corridor examined by Dr. Reiss could the installation have any effect on these shipwrecks. However, because of the methods of installation and the use of navigational equipment, including global positioning systems and sonar, it is highly unlikely that the installation would stray outside the 200 ft corridor.

Cable Specifications

Since the cable would be buried at a depth of 1.5 m, once installed, it would have no effect on any cultural or historical resources in the project area.

Cable Installation

Due to the lack of any identified cultural or historical resources along the Preferred Alternative route, no impacts are anticipated.

Obstacles found along the route outside the boundaries of the sanctuary were avoided in the design of the cable routing. In addition, the sea plow is equipped with obstacle-avoidance sonar that continuously scans the terrain up to 200 meters ahead of the plow; therefore, the route can be altered if obstacles are detected.

Operation and Maintenance

Any operation and maintenance activities that might be necessary in the future would not affect any known cultural or historical resources, since there currently are no such resources in the vicinity of the Preferred Alternative route. However, cultural and historical resources may be found in the vicinity of the cable in future years. Therefore, any operation and maintenance activities would be preceded by a detailed study to determine whether any cultural or historical resources were located in the vicinity of the area in which those activities would take place.

4.1.6 Lifecycle Assessment and Cumulative Effects on Stellwagen Bank National Marine Sanctuary

Life-Cycle Issues

The Hibernia cable is designed for a life expectancy of 25 years. There are three possible options for the cable when it has been determined that the cable is at the end of its useful life for commercial purposes. The cable could be donated to the scientific community, it could be left in place, or it could be removed. The determination of the best option would be made at the end of the project life, in order to consider conditions that may be present after 25 years. Additionally, technological advances might make cable removal easier and less environmentally intrusive. Such determination will be made by the Superintendent of the Stellwagen Bank NMS.

At the end of the project's useful commercial life, the applicant would conduct a survey of the cable route to assess status of the cable and nearby benthic habitat. It is estimated that within two years after cable burial, benthic organisms would have re-colonized most areas disturbed by cable installation. After 25 years of burial, benthic communities will have colonized other areas in and near the cable route that have favorable conditions, and abandoned areas that are less favorable. Such conditions can be expected to change over a 25-year period, based on water depth, temperature, salinity, sediment suspension, access to food, fishing, and other factors. Therefore a survey prior to a decision on removal or leaving the cable in place would be necessary.

At the end of the cable's service, the permit holder shall provide notification in writing to the Stellwagen Bank NMS Superintendent that the cable will no longer be used for commercial purposes. The permit holder shall then perform a survey of the cable route and provide a report to the Superintendent describing the status of the cable (including burial depth) and benthic communities along the cable route. The permit holder shall then prepare an evaluation of leaving the cable in place or removal of the cable. This report, to be provided to the Superintendent, shall include: 1) a full description of removal procedures; 2) a description of the type and frequency of monitoring operations, if the cable were to be left in place; 3) a complete evaluation of the environmental effects of both approaches; and 4) other potential approaches.

The removal process would likely require the use of an ROV using water jets to fluidize sediments over the cable, to the buried depth of approximately 1.5 m. The ROV jetting method would liquefy the substrate above the cable to the burial depth. The jets would be required along the entire length of the approximately 19.5 km of cable buried in the Stellwagen Bank NMS. After the cable had been unburied, a grapnel would be used to grasp the cable and bring it to the surface. Portions of the cable that were outside of the Sanctuary might perhaps be split off.

Fluidization of sediments to a depth of 1.5 m, along a 19.5 km corridor through the Sanctuary, would likely represent a more substantial environmental effect than would the cable burial itself. Removal of buried cable could likely have a number of impacts to benthic sediments, marine communities, and water quality. Fluidizing sediments over the buried cable would disperse marine sediments into the water column. Due to the operation of the ROV as compared to the Sea Plow VII, the amount of disturbed sediment would be somewhat larger than that disturbed during installation. Benthic communities along the route would be disturbed, with some species harmed by the amount of sediment that would be disturbed, and later deposition back onto the sea bed.

Cumulative Effects

Because the Stellwagen Bank NMS essentially spans the entrance to Massachusetts Bay, it is likely that some future cable projects designed to land in the Boston metropolitan area would be proposed to be located in the sanctuary. It is difficult to predict the exact number of cable projects that eventually may be proposed, since project information often is proprietary until shortly before the project is announced. However, on the basis of current industry trends and market requirements, it is anticipated that four additional cable projects are likely to land in the Boston metropolitan area within the next five years (Earth Tech 1999).

The future projects are expected to provide additional communication links to Europe and points along the eastern coast of the U.S. One or two of the projects might be "festoon" projects, which are unrepeatered cables that make short jumps along the coastline. A direct link down the East Coast to the Florida area is another possibility, as is another direct Atlantic crossing to Europe (Earth Tech 1999).

Given the above scenario, it is possible to predict that as many as five fiber-optic cables could be proposed for siting within the sanctuary over the next five years. The two transatlantic projects likely would follow the Preferred Alternative route described in this EA. The East Coast and festoon projects likely would have their own independent routes, which may or may not affect the sanctuary. Projects that may be routed through the sanctuary would be evaluated on a case-by-case basis to consider the cumulative effects of previous and future projects (NOAA 2000).

The current industry standard for minimum separation of ocean cables is 500 m in shallow water and two to three times water depth in deep water (whichever is greater). When there are two cables in confined areas, the spacing can be less, if so agreed by both parties involved, particularly in waters that are less than 300 m deep. The spacing is necessary to protect adjacent cables from activities associated with the installation or repair of another cable (Earth Tech 1999; 360networks, inc. 2000c). The industry standard also dictates that the route should be engineered with crossing angles as close to 90° as possible (360networks, inc. 2000b).

The cumulative effects of the location of five or more submarine cables within Stellwagen Bank NMS are the most significant of the predicted effects of the proposed project. For the proposed project, it is estimated that a total of 4.8 acres of sea bed would be disturbed; under the assumption that four additional projects of similar design will be undertaken in the next five years, the total amount of disturbed acreage would be approximately 24 acres (4.8 acres x 4 additional projects = 19.2 acres, plus 4.8 acres for this project yields a total of 24 acres for the five projects). Since future decisions about cable placement can be based on the benefits and effects of the projects proposed, the current proposed action should not set a precedent and should be judged solely on its own merits.

4.2 NORTHERN ALTERNATIVE

This section describes the environmental impacts of the Northern Alternative to the water; geologic; biological; cultural and historical; and socioeconomic resources of the project area. Note that a lesser degree of detailed information was available to support this evaluation.

4.2.1 Water Resources

Cable Route

The Northern Alternative route avoids areas of known contamination, such as those discussed in Section 3. Therefore, it is not expected that significantly contaminated soils would be encountered along the proposed route, and effects on water resources as a result of the route selection would be minimal.

Cable Specifications

The cable is constructed of optical fibers surrounded by a copper conductor and steel strength members, and is contained within a polyethylene tube that should prevent any leaching of metals into the environment. The cable for the Northern Alternative would be more heavily armored than the cable for the Preferred Alternative. Armoring of the cable is accomplished by steel wires, which are coated with a compound produced from pine tar. The compound contains no petroleum-based products and does not decompose or break down. Therefore, once installed, the buried cable would not cause in any subsequent alterations in amounts of suspended sediment or levels of water turbidity. No long-term effects on water quality as a result of the degradation of the cable system are anticipated.

Cable Installation

Discharges of sanitary waste and bilge water, minor fuel oil spills, and disposal of general debris could cause temporary, minor, local effects on water quality as a result of operation of vessels during installation of the cable. It is possible that minor amounts of petroleum products generated by normal ship operation could enter the water during installation. However, vessels would operate in accordance with the regulations of the USCG and other applicable regulations, in a manner similar to the operations of any other commercial vessel in U.S. waters.

The temporary disturbance of sediments caused by installation of the cable should have no significant effect on water quality or cause harm to marine biota through increased levels of toxicants. Because of the use of sea plow technology, rather than the more traditional cut-and-cover technology, disturbance of the sea bed and any potentially contaminated sediments would be minimal and temporary. Conditions typically associated with dredging operations, such as suspension, side-casting, or permanent removal of sediment, would be avoided. The slow speed at which the ship travels when plowing and installing cable would further minimize disturbance of sediment, and help prevent collisions with other vessels that could contribute to the discharge of contaminants such as petroleum products to ocean waters.

Operation and Maintenance

Once the cable has been installed, operation of the cable should have no effect on sediment or water quality. In the unlikely event of a cable fault, repair operations generally would necessitate unburying the cable in the vicinity of the damage and bringing it to the surface for repair. After repair, the cable would be reburied by a remotely operated vehicle. Section 2 presents a more detailed discussion of cable repair. Repair operations would cause temporary disturbance of sediment, suspension of sediment in the water column, and disturbance of benthic communities.

4.2.2 Geologic Resources

Cable Route

The potential that mining of sand and gravel will be undertaken along the Northern Alternative route may be limited because of the nature of the materials present, the depth of the water, and the potential that recovery of materials would be difficult and costly. It is not anticipated that selection of the Northern Alternative route would affect the ability to extract resources from the area.

The Northern Alternative route avoids areas of known contamination, such as those discussed in Section 3. Therefore, it is not expected that significantly contaminated soils would be encountered along the proposed route, and effects on geologic resources as a result of the route selection would be minimal.

The Northern Alternative route would be selected so that the cable could be buried in the softest bottom types to avoid unnecessary effects on the environment. Table 4-2 shows bottom types affected by length and percentage of the total Northern Alternative route.

Table 4-2: Bottom Types Along the Northern Alternative Route

Bottom Type	Length (km)	Percentage of Route (%)
Gravel (Mixed Course)	10.00	5
Sand	23.70	11
Mud	119.90	55
Mud (Silt/Clay)	66.30	30
Total	**219.90**	**100**

Source: Seafloor Surveys International, Inc. 1999. The Northern Alternative route would be approximately 104.6 km longer than the Preferred Alternative route.

Cable Specifications

The cable is constructed of optical fibers surrounded by a copper conductor and steel strength members and is contained within a polyethylene tube that should prevent any leaching of metals into the environment. The cable would be armored by steel wires and coated with a compound produced from pine tar. The compound contains no petroleum-based products and does not decompose or break down. Therefore, no long-term effects on sediment quality as the result of degradation of the cable system are anticipated.

Cable Installation

The project would involve the temporary disturbance of ocean bottom sediments to a 1-m-wide by 1.5-m-deep wedge in the sediments to bury the cable. The width of the plow is 4.6 m, including the skids. The skids “float” on the surface of the sea bed, rather that disturbing it. Therefore, the width of the area of disturbance would be the width of the plowshare (1.5 m deep and 1.0 m wide by approximately 219.9 km, or a total of approximately 54.34 acres of disturbed sea bed) (Seafloor Surveys International, Inc. 1999).

Cable installation should cause only minor, local, and temporary suspension of sediment along the cable route, since the ship towing the plow would travel at a speed of only 0.5 to 1 knot and the area to be disturbed is narrow. The sediment that is disturbed is displaced sideways and upward, but would fall back into the trench immediately after the plow passes and the cable is inserted into the trench. As the sediments are disturbed, any contaminants bound to the sediments could possibly be resuspended temporarily. The temporary disturbance of sediments caused by installation of the cable should have no significant effect on sediment or water quality or cause harm to marine biota through increased levels of toxicants.

Operation and Maintenance

No long-term hydrographic events are expected to affect the cable, once installation has been completed. Normal seasonal currents currently affect the sea-floor sediments, but those currents have caused no mass removal of sediment that would suggest the cable might become exposed. Any significant events, such as hurricanes or 100-year storms, should not affect the sea-floor sediments in a manner that would expose the cable.

The storm of record in the area is the Halloween Storm of 1991. Examination of bathymetric charts from both before and after the storm shows that the sea floor has not changed to any great degree. The depth of water, coupled with the depth at which the cable will be buried, should ensure that the cable remains buried.

4.2.3 Biological Resources

The potential effects of the Northern Alternative on biological resources in the vicinity of the project area are described below. The resources discussed correspond to those presented in Section 3 and include fish; benthic communities; marine mammals, reptiles, and birds; and plankton. The effects on each resource are presented as above, by cable route, specifications, installation, and operations and maintenance.

4.2.3.1 Fish

Cable Route

Demersal fish that inhabit the cable route lay their eggs in the fall or early winter, and hatching usually occurs before spring. Installation of the cable on the U.S. portion of the route is expected to take place spring or summer 2000, after the eggs have hatched, thereby eliminating any direct effects, such as displacement of eggs.

Cable Specifications

Once installed, the buried cable is not anticipated to have any effects on fish species in the area. Because a portion of the Northern Alternative route would be unburied (1.262 km), the applicant proposes to use more heavily armored cable (see Section 2.2.2 and Figure 2-5) to protect against potential breakages. Based on this armoring, it is considered by the applicant to be very unlikely that the cable would break. In addition, breakage would not be expected to release hazardous materials into the marine environment due to the insulating gel that further protects the cable from water ingress. See Appendix B for additional technical data on the proposed cable materials.

Cable Installation

The habitat of both eggs and adults of the species of demersal fish found in the area would be disturbed temporarily during the plowing of the 1 m wide by 1.5 m deep wedge in the sediments to bury the cable. The result should be only minor and temporary disturbance of sediment and any bottom-dwelling fish or the eggs of those fish along the route. The sediment that would be disturbed would be displaced sideways and upward, but would fall back into the trench immediately after the plow passes and the cable is inserted into the trench. The alteration of other aspects of the habitat of demersal fish species, such as loss of prey, would be local and temporary and is not expected to have any measurable effect on populations of demersal fish species. Temporary displacement of some fish from the immediate vicinity (that is, tens of feet) of the cable route would occur during operation of the plow. Those impacts also would be of a temporary and local nature.

Pelagic fish should not be affected significantly by installation of the cable. Installation of the cable in coastal waters would take less than two days. It is not expected that any minor pollution effects from the operations of ships would affect those fish species.

Operation and Maintenance

Since almost all of the Northern Alternative cable is buried permanently, the cable itself, as well as operation and maintenance of the cable, would have no long-term effects on demersal or pelagic fish species, their reproduction, or their habitat.

4.2.3.2 Benthic Communities

Cable Route

The benthic communities present along the Northern Alternative route are those associated with mixed soft-bottom areas and hard rock sea bed. Effects on those communities would be greater for the Northern Alternative than for the Preferred Alternative because a greater length of cable would be installed under that alternative.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it is not anticipated to have effects on any benthic organisms present in the project area.

Cable Installation

Environmental effects on benthic communities would result from operation of the plow. The project would involve the temporary disturbance of ocean bottom sediments while plowing a 1-m-wide by 1.5-m-deep wedge in the sediments to bury the cable. The width of the plow is 4.6 m, including the skids. The skids “float” on the surface of the sea bed, rather that disturbing it. Therefore, the width of the disturbed area would be the width of the plowshare (1.5 m deep and 1.0 m wide, by approximately 219.9 km, or a total of approximately 54.34 acres of disturbed sea bed) (360networks, inc. 2000a, Seafloor Surveys International, Inc. 1999). Regardless of the additional length of cable, the effects on the benthic community are considered to be not significant.

During installation of the cable, sedentary and slow-moving benthic organisms would be injured and killed. The plow blade may contact such organisms, and the wheels of the plow may crush some individuals. More mobile benthic species, such as groundfish, lobsters, and crabs, would be expected to avoid direct contact by moving out of the way of the sea plow (NMFS 2000, Earth Tech 1999).

Because the amount of disturbance of soil required for installation is minimal and the disturbed area would be restored immediately to preinstallation conditions, effects on the marine environment would be minimal. In addition, installation of the cable progresses slowly, at a rate of approximately 0.5 to 1.0 knot, thereby limiting the potential that the plow would affect benthic habitats adversely. Given the narrow area of temporary disturbance of sediment, it is anticipated that much of the benthic infauna and epifauna would recolonize the area in which the cable was laid within a matter of weeks or months. In some cases, recolonization would not occur until the next spawning season.

Operation and Maintenance

It is not expected that, after installation of the cable, the project will affect marine resources or activities because the cable would be buried to a depth of approximately 1.5 m beneath the sea bed. The location of the route also would be charted to alert mariners to the presence of the cable.

Operation of the cable should not have any effects on the benthic community. In the unlikely event of a cable fault, repair operations would necessitate unburying the cable in the vicinity of the damage and bringing it to the surface for repair. After repair the cable would be reburied by a remotely operated vehicle. Repair operations would cause temporary disturbance of sediment, suspension of sediment in the water column, and disturbance of benthic communities.

4.2.3.3 Marine Mammals

Potential effects on marine mammals include ship strikes during installation, entanglements during deployment of the cable, disturbances caused by induced electrical fields, disturbances caused by cable strumming, and entanglements associated with non-buried sections of the cable (NMFS 2000; 360networks,inc. 2000b).

Cable Route

The project area provides important feeding habitat for a number of species of whale. Marine mammals are known to feed and nurse in the project area and to migrate through it.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it is not anticipated to have effects on any marine mammals in the project area. However, NMFS has not formally evaluated the Northern Alternative and additional consultations would be required if it were to be selected.

Cable Installation

Any effects from the cable-laying ship likely would not differ from those of other vessel traffic common throughout the region. It is possible that the cable-laying ship might collide with a marine mammal along the cable route or that a marine mammal might become entangled in the cable during installation. However, it is likely that the speed of the ship during cable-laying activities would be slower than that of migrating whales or seals. NMFS concluded that, as long the speed of the cable ship during installation was no more than 1.0 knot, installation would not be likely to adversely affect endangered whales that may be present in the project area (NMFS 2000).

The potential for disturbance of marine mammals as a result of induced electrical fields was evaluated and found to be insignificant. The electrical field induced around the cable is proportional to the rate of change of current flowing through it. Since the cable carries direct current (DC) only, there is no rate of change of current, so there is no electric field around the cable, except when the cable is powered up or down. The power-up procedure typically takes several minutes, so the induced electric field is negligible.

For the Hibernia system, the current is 0.4 amp for the initial system. Ultimately, it would not exceed 0.7 amp, which is less than many household appliances (for example, a typical toaster draws 12 amps).

The intensity of the magnetic field at a distance of 1 m from the cable with a 0.7 amp current will be 0.14 micro-tesla. The intensity of the naturally occurring magnetic field at the surface of the earth ranges from 300 micro-teslas at the equator to 600 micro-teslas at the poles. Therefore, the magnetic field at a distance of 1 m from the cable is more than 2,000 times less intense than the naturally occurring magnetic field of the earth (360networks 2000b).

Operation and Maintenance

After the cable has been installed, entanglements of marine mammals would be unlikely because the cable is to be mostly buried along the Northern Alternative route. NMFS concluded that the cable would not be likely to adversely affect endangered whales if it were buried to a depth of 1.5 m beneath the sea bed. NMFS also recommended that post-deployment surveys be conducted within 30 days of the installation of the cable, and again four years after installation, to document that target depths of deployment were reached (NMFS 2000). Identification of the potential effects of unburied portions of the cable along the Northern Alternative route would require additional consultation with NMFS.

The geologic conditions present along the Northern Alternative route include rock outcroppings and crevasses. A concern related to those areas is the speed of ocean currents and their potential to cause cable “strumming.” Strumming would be the result of the oscillating forces exerted on a suspended member when turbulent vortexes move past the member. Strumming could occur in a cable if a section of cable were suspended above the sea bed, and a current of sufficient velocity moved perpendicular to the cable. The frequency and amplitude of the oscillations would be a function of the suspension length, the shape of the suspended member, the velocity of current, and the natural frequency of the cable. Suspension length would be a function of the relief found along a cable route.

Burial of cable using modern slack control systems, such as those proposed for use on this project, as well as selection of a low-relief route, would provide mitigation of suspensions and strumming. Any vibration in the cable would be expected to be below the hearing range of marine mammals. Therefore, suspensions and strumming would not be expected to cause an adverse effect on marine mammals (360networks, inc. 2000b). However, NMFS has not formally evaluated the potential effects of any unburied and/or suspended segments along the Northern Alternative route. Selection of the Northern Alternative would require additional consultations with NMFS.

In the unlikely event of a cable fault, it might be necessary to apply an electroding signal to the cable to locate the fault. If an electroding signal were applied to the cable, a low-level AC signal would be generated, with a frequency in the range of 15 to 25 Hz for the short time period necessary to locate the fault.

4.2.3.4 Marine Reptiles

Marine reptiles could be affected by the Northern Alternative route in a number of ways. Ship strikes could occur during installation of the cable, and entanglements could take place, both during deployment of the cable and after installation, if any portion of the cable is unburied (NMFS 2000).

Cable Route

The project area provides important feeding habitat for a number of species of marine reptiles. Marine reptiles are known to feed and nurse in the project area and to migrate through it.

Cable Specifications

As nearly all the cable would be buried at a depth of 1.5 m, once installed it is not anticipated to have effects on any marine reptiles in the project area.

Cable Installation

No temporary or permanent effects on marine reptile populations are likely or expected as a result of installation of the fiber-optic cable, which would not affect the habitat of those populations. There is a slight potential that marine reptiles might become entangled in the ship lines during installation of the cable, or collide with the vessel performing the installation. However, the lines are maintained fairly taut, and entanglement is unlikely. The potential for ship strikes and entanglements during deployment would also be reduced by the slow speed of the ship during installation. It is proposed that the deployment speed would be between 0.5 and 1.0 knot.

Operation and Maintenance

No temporary or permanent effects on marine reptile populations are likely or expected as a result of operation of the fiber-optic cable, which would not affect the habitat of those populations.

After installation of the cable, the potential for entanglements would be eliminated because the cable would be buried along most of the Northern Alternative route. It is recommended that post-deployment surveys be conducted within 30 days after installation of the cable, and again four years after installation, to document that target depths of deployment were reached. Identification of the potential effects of unburied portions of the cable along the Northern Alternative route would require additional consultation with NMFS (NMFS 2000).

4.2.3.5 Marine Birds

Cable Route

The area of the Northern Alternative route provides important feeding habitat for a number of species of marine bird. However, no effects on the feeding habitat of those species would be expected under the Northern Alternative.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it would not have any effects on marine birds in the project area.

Cable Installation

No permanent effects on populations of marine birds are likely or expected as a result of installation of the fiber-optic cable. The cable is to be installed at sufficient depth that the temporary disturbance would not influence the feeding activities of either surface-feeding or diving bird species, in terms of both their spatial feeding area and their prey. Many such birds are adapted to frequenting areas used by fishing and other vessels; the presence of additional vessels during the short installation period therefore will not have a negative effect on their abundance.

There will be no temporary or permanent impacts on the one federally listed endangered bird species, the Roseate tern. The recovery plan for the tern focuses on protecting breeding colonies, but availability of prey may limit population recovery by the species. The proposed project is not expected to have an effect on the availability of prey, and therefore would have no effect on the species. However, if the cable is to installed during the months of August and September, which is the period during which the Roseate tern prepares for migration, FWS must be advised (FWS 1999).

No mitigation measures are necessary because there will be no temporary or permanent effects on marine birds as a result of installation of the fiber-optic cable under the Northern Alternative.

Operation and Maintenance

No permanent effects on marine bird populations are likely or expected as a result of operation or maintenance of the fiber-optic cable. Therefore, no mitigation measures are necessary.

4.2.3.6 Plankton

Cable Route

The area of the Northern Alternative route provides important habitat for a number of species of zoo- and phytoplankton. However, no effects on the habitat of those species would be expected under the Northern Alternative.

Cable Specifications

Since nearly all the cable would be buried at a depth of 1.5 m, once installed it is not anticipated to have any effects on any species of plankton in the project area.

Cable Installation

No temporary or permanent effects on populations of phytoplankton or zooplankton are likely or expected as a result of installation of the fiber-optic cable. The cable is to be installed at sufficient depths that the temporary disturbance will not influence the distribution or abundance of plankton. No mitigation measures are necessary, since there will be no temporary or permanent effects on plankton as a result of installation of the fiber-optic cable under the Northern Alternative.

Operation and Maintenance

No temporary or permanent effects on populations of phytoplankton or zooplankton are likely or expected as a result of operation and maintenance of the fiber-optic cable. No mitigation measures are necessary, since there will be no temporary or permanent effects on plankton as a result of operation and maintenance of the fiber-optic cable under the Northern Alternative.

4.2.4 Socioeconomic Resources

The potential effects of the Northern Alternative on the socioeconomic resources of the region are described below. The resources described correspond to those presented in Section 3: commercial fishing, commercial shipping and navigation, whale watching, recreational fishing, bird watching, boating, and diving.

It is important to note that the cost of the Northern Alternative would exceed that of the Preferred Alternative by approximately $12 million, because of the additional length of cable and additional installation time associated with the Northern Alternative.

4.2.4.1 Commercial Fishing

Cable Route

The applicant would not apply for an exclusion zone for the cable route under the Northern Alternative, although some portions of the cable would be unburied. However, the applicant would coordinate arrangements with applicable marine charting authorities to chart the unburied cable area (360networks, inc. 2000a).

Cable Specifications

To avoid interference with important commercial fisheries and the gear used by those fisheries, the cable would be heavily armored for protection against breakage and buried, whenever possible. The cable armor for the Northern Alternative would be heavier than that for the Preferred Alternative, as described above. Since most of the cable would be buried to 1,500 m for protection against existing and future fishing activity, it would not be a significant threat to boat anchoring or use of most fishing gear, such as bottom-set long line, gillnets, and lobster pots and traps.

The proposed cable would be protected from contact with fishing gear by armoring and burial in the sea bed, whenever possible. Further, fishermen would not be held liable if they damage the cable (whether the damage occurs during the cable's operational life or after abandonment) while using traditional fishing methods and gear, unless such damage is intentional or egregious. In addition, should a fisherman's gear become snagged on the cable and be sacrificed, the applicant would reimburse the fisherman for the gear, provided that timely notice is given and that appropriate evidence is provided to show that the gear was sacrificed to avoid further damage to the cable (Earth Tech 1999).

Cable Installation

During installation of the cable, the applicant would take a number of actions to ensure that commercial fishing vessels are fully aware of the installation. Such actions will include:

- Deploy patrol vessels in high-traffic areas
- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners
- Air VHF broadcasts during installation period
- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

Installation of the cable along the Northern Alternative route should take approximately six days longer than installation along the Preferred Alternative route, but should not interfere significantly with active fishery operations. Pelagic fisheries along the cable route that could be affected by the scheduling of the installation are active primarily from May through December. There should be no significant threat to boat anchoring or the use of most of the desired fishing gear. Fishermen would be notified before the cable installation, so damage to gear during installation can be avoided. The cable route would avoid the most active fishing grounds, in particular all identified scallop, clam, and quahog beds along the Northern Alternative route, insofar as possible.

Installation of the cable is not expected to effect commercial fishing, even if the installation occurs in the May to December timeframe. In areas in which marine activity is heavy, it is possible to install a cable by working closely with other mariners and requesting a small (2-mile) moving corridor around the cable ship in which fishing is restricted. Fishermen would be requested to keep their gear at least 1 mi away from the cable ship on each side and 2 mi away from the cable ship ahead and aft. Intensive liaison with fishermen using static gear such as gillnets and lobster pots would minimize any potential for conflict.

Operation and Maintenance

Bottom-trawling is the fishing method most likely to be affected by the cable, because its use is widespread and it entails a high level of effort. Further, the nature of the trawling gear entails a risk of entanglement, and the method involves penetration of the sea bed. Trawling gear penetrates, on average, 5 to 20 cm into the ocean bottom, and can be up to 55 m in width, thereby affecting a large area. Usually tows are conducted at known productive fishing grounds that have been charted and follow a narrow-range depth contour along the prevailing current pattern. Except during times of regulatory closures, trawl fishing is especially heavy on Jeffrey's Ledge, Stellwagen Bank, and Georges Bank, but it occurs in all areas of the central Gulf of Maine at some time each year.

4.2.4.2 Commercial Shipping and Navigation

Cable Route

While commercial shipping does take place in the vicinity of the Northern Alternative route, the Northern Alternative route is expected to have no significant effect on commercial shipping.

Cable Specifications

Since nearly all the cable would be buried at a depth of 1.5 m, once installed it would not have any effects on commercial shipping activities in the project area.

Cable Installation

No significant effects on commercial shipping are expected. The installation of the cable line would take place over a period of less than one week along the Northern Alternative route and should not interfere with commercial shipping lanes.

While oil spills that result from collisions of vessels are always a threat, the implementation of the Vessel Traffic Separation Scheme has minimized the potential for such collisions. Of 105 vessel casualties in the period from 1984-1988, 93 percent involved fishing vessels, and only two (less than 2 percent) involved commercial vessels (NOAA 1993, cited in Earth Tech 1999). Given the volume of commercial ship traffic in the area, there is little potential for collisions in general, and the prospects of a significant spill caused by collisions between usual traffic and the cable installation vessel during the cable installation period is even more remote.

During installation of the cable, the applicant would take a number of actions to ensure that commercial shipping organizations are fully aware of the installation. These include:

- Deploy patrol vessels in high-traffic areas
- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners

- Air VHF broadcasts during installation period
- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

To maintain the security of the cable-laying operation at the stern of the ship, it is possible that commercial vessels may be hired to prevent other boats from intruding into the area. Otherwise, cable-laying is a specialized field, and it is unlikely that the local labor force would be used. Similarly, the cable-laying ship is self-contained; therefore, ancillary facilities and support for a work force, such as temporary housing and locally supplied food and clothing, are not needed.

All appropriate navigation regulations and precautions would be followed to ensure that commercial vessels are not impeded during the short period of cable installation.

Operation and Maintenance

Operation of the cable is not expected to have any effects on commercial vessels because nearly all of the cable would be buried beneath the sea bed (Earth Tech 1999). Performance of maintenance activities would be preceded by notification of the commercial shipping industries, as discussed above.

4.2.4.3 Whale-Watching

Cable Route

The project area provides important habitat for a number of species of whale. Consequently, vessels of the whale-watching industry frequently visit the area. The Northern Alternative route is expected to have no effect on the whale-watching industry.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it would have no effect on the whale-watching industry in the project area.

Cable Installation

Installation of the cable is not expected to have any significant effect on whale-watching in the project area, even if installation takes place in the primary whale-watching season, from May through July. In areas in which marine activity is heavy, it is possible to install a cable by working closely with other mariners and requesting a small (2-mile) moving corridor around the cable ship in which ship traffic is restricted.

Operation and Maintenance

Operation of the cable is expected to have no effect on the whale-watching industry. In the unlikely event that cable maintenance becomes necessary, the performance of maintenance activities would be preceded by notification of commercial shipping industries, as discussed above.

4.2.4.4 Recreational Fishing

Cable Route

The applicant would not apply for an exclusion zone for the cable route in the Northern Alternative route, although some portions of the cable would be unburied. However, the applicant would coordinate arrangements with applicable marine charting authorities to chart the unburied cable area (360networks, inc. 2000a).

Cable Specifications

The cable would be armored for protection against breakage and buried along nearly the entire Northern Alternative route. Since nearly all of the cable (out to the 1,500 m contour) would be buried for protection against existing and future fishing activity, it would not be a significant threat to boat anchoring or use of most fishing gear.

The proposed cable would be protected from contact with fishing gear by armoring and burial in the sea bed wherever possible. Further, fishermen would not be held liable if they damage the cable (whether the damage occurs during the cable's operational life or after abandonment) while using traditional fishing methods and gear, unless such damage is intentional or egregious. In addition, should a fisherman's gear become snagged on the cable and be sacrificed, 360networks, inc. would reimburse the fisherman for the gear, provided that timely notice be given and that appropriate evidence be provided to show that the gear was sacrificed to avoid further damage to the cable (Earth Tech 1999).

Cable Installation

The installation and operation of the cable are expected to have no significant effect on recreational fishing activities. All appropriate navigation regulations and precautions would be followed to ensure that recreational fishing vessels are not impeded during the short period of cable installation.

During installation of the cable, the applicant would take a number of actions to ensure that operators of the recreational fishing vessels are fully aware of the installation. These include:

- Deploy patrol vessels in high-traffic areas
- Conduct a public awareness program (initially undertaken in the initial stages of the project - would continue after installation)
- Formal notices to mariners
- Air VHF broadcasts during installation period

- Publish notices of interest to commercial and recreational fishermen in appropriate periodicals
- Provide representatives of fishing interests with opportunities to be present on board the installation vessel (as was done during the route survey)

Operation and Maintenance

Operation of the cable would have no effect on recreational fishing vessels because nearly all of the cable would be buried in the sea bed. Performance of maintenance activities would be preceded by notification of other mariners, as discussed above.

4.2.4.5 Bird Watching, Recreational Boating, and Diving

Cable Route

The project area is an important site for participation in a number of recreational activities, including bird watching, recreational boating, and diving. However, the Northern Alternative route is expected to have no effect on such activities.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it would have no effect on any recreational activities undertaken in the project area.

Cable Installation

Installation of the cable is not expected to have significant effect on recreational activities in the project area. In areas that are heavily used for such activities, it is possible to install a cable by working closely with other mariners and requesting a small (2-mile) moving corridor around the cable ship in which ship traffic is restricted. This restriction could affect recreational activities during installation of the cable in the vicinity of such activities. Some temporary loss of boating area in the vicinity of the cable-laying vessel would be necessary to secure the umbilical and equipment towed behind the ship. The applicant would work with the boating community to keep mariners informed of the schedule for cable-laying operations.

Operation and Maintenance

Operation of the cable is expected to have no effect on recreational activities. In the unlikely event that maintenance of the cable becomes necessary, the performance of maintenance activities would be preceded by notification of other mariners, as discussed above.

4.2.5 Cultural and Historical Resources

Cable Route

The Northern Alternative route has been designed to avoid charted wrecks, and the ocean floor would be surveyed before construction begins to confirm that all would be avoided (Earth Tech 1999). Only a review of available sources was conducted for the Northern Alternative route. Therefore, formal route surveys, as well as SHPO consultations would likely be required if this alternative were to be selected.

Cable Specifications

Since nearly all of the cable would be buried at a depth of 1.5 m, once installed it would have no effect on any cultural or historical resources found in the project area.

Cable Installation

Obstacles found along the Northern Alternative route were avoided in the design of the cable routing. In addition, the sea plow is equipped with obstacle-avoidance sonar that continuously scans the terrain up to 200 meters ahead of the plow; therefore, the route can be altered if obstacles are detected.

Operation and Maintenance

Any operation and maintenance activities that might be necessary in the future would not affect any known cultural or historical resources, since the Northern Alternative route would be designed to avoid those resources, once they have been identified by a survey of the ocean floor. However, additional cultural and historical resources may be found in the vicinity of the cable in future years. Therefore, any operation and maintenance activities would be preceded by a detailed study to determine whether any cultural or historical resources were located in the vicinity of the area in which those activities would take place.

4.2.6 Lifecycle Assessment and Cumulative Impacts to Stellwagen Bank National Marine Sanctuary

The Hibernia cable is being designed for a life expectancy of 25 years. Traditionally cables are left in place after their commercial life. Nearly all of the cable along the Northern Alternative route would be buried, and only a short segment would be exposed on the sea bed. If left in place, the applicant has stated that the cable may be donated to the scientific community for monitoring of sea bed instruments (360networks, inc. 2000a). Resurvey and/or removal requirements may be imposed as a condition of authorization or approval by cognizant agencies.

It is likely that some future cable projects designed to land in the Boston metropolitan area would be located in the vicinity of the Northern Alternative route. It would be quite difficult to predict the exact number of cable projects that eventually may be proposed, since project information often is proprietary until shortly before the project is announced. However, on the basis of current industry trends and market requirements, it is anticipated that four additional cable projects are likely to land in the Boston metropolitan area within the next five years (Earth Tech 1999).

The future projects are expected to provide additional communication links to Europe and points along the eastern coast of the U.S. One or two of the projects might be "festoon" projects, which are unrepeatered cables that make short jumps along the coastline. A direct link down the East Coast to the Florida area is another possibility, as is another direct Atlantic crossing to Europe (Earth Tech 1999).

The current industry standard for minimum separation of ocean cables is 500 m in shallow water and two to three times water depth in deep water (whichever is greater). When there are two cables in confined areas, the spacing can be less, if so agreed by both parties involved, particularly in waters that are less than 300 m deep. The spacing is necessary to protect adjacent cables from activities associated with the installation or repair of another cable (Earth Tech 1999; 360networks, inc. 2000c). The industry standard also dictates that the route should be engineered with crossing angles as close to 90° as possible (360networks, inc. 2000b).

The cumulative effects of the location of five or more submarine cables in the vicinity of the Northern Alternative route is the most significant of the predicted effects of the proposed project. For the proposed project, it is estimated that a total of approximately 32 acres of sea bed would be disturbed; under the assumption that four additional projects of similar design will be undertaken in the next five years, the total amount of disturbed acreage would be approximately 160 acres (32 acres x 4 additional projects = 128 acres, plus 32 acres for this project yields a total of 160 acres). Since future decisions about cable placement can be based on the benefits and effects of the projects proposed, the current proposed action should not set a precedent and should be judged solely on its own merits.

4.3 NO ACTION ALTERNATIVE

Because the no-action alternative does not involve the installation, operation, and maintenance of a submarine fiber-optic cable, no effects on resources in the region would occur under that alternative.

5.0 FINDING OF NO SIGNIFICANT IMPACT (FONSI)

6.0 LIST OF PREPARERS

This EA was prepared under U.S. Department of Commerce, NOAA contract number 56WCNA001041 by Tetra Tech Inc.

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Appendix A

Consultation Letters and Information

PUBLIC NOTICE

US Army Corps
of Engineers
New England District

696 Virginia Road
Concord, MA 01742-2751

Date: November 2, 1999
Comment Period Ends: December 2, 1999
File Number: 199902369
In Reply Refer To: Mr. Laurie Suda
or by e-mail to: laurie.suda@usace.army.mil

Worldwide Telecom Inc., 1066 West Hastings Street, Vancouver, BC, Canada, V6E 3X1 has requested a Corps of Engineers permit under Section 10 of the Rivers and Harbors Act of 1899, to install a marine fiber optic cable from Nova Scotia, Canada, crossing into United States waters in the Gulf of Maine, and making landfall at Lynn Beach, Lynn, MA as shown on plan entitled "Figure 2-4". Two alternate routes are being considered as shown on the plan entitled: "Figure 2-1".

The cable will be launched from a surface vessel to a towed seaplow, which will open a furrow in the ocean substrate, place the cable to a minimum depth of one meter, and close the furrow over the laid cable. At a point approximately 1250 meters offshore at Lynn, and seaward of the outermost edge of a submerged aquatic vegetation (SAV) bed, the deployment will transition to a directional bore under the SAV, surfacing landward of the high tide line on the beach, as shown on the plan entitled: "Figure A-1".

The cable is 2 inches in diameter. There will be periodic installations of in-line repeaters, approximately 1 foot in diameter and 5' long. In addition to the fiber optic signal, there is provision for a 3.5Kvolt dc current to power the repeaters.

With regard to Essential Fish Habitat, the proponent will provide an assessment of temporary construction impacts on a wide variety of federally managed fisheries resources, with appropriate mitigation components. The National Marine Fisheries Service will make conservation recommendations as necessary.

Landfall for this project is located on the USGS Lynn quadrangle sheet at UTM coordinates N 4702.1 and E 0340.8.

In order to properly evaluate the proposal, we are seeking public comment. Anyone wishing to comment is encouraged to do so. Comments should be submitted in writing by the above date. If you have any questions, please contact Mr. Laurie Suda at (978) 318-8493 or use our toll free number (800) 343-4789 or (800) 362-4367, if calling from within Massachusetts.

Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider the application. Requests for a public hearing shall specifically state the reasons for holding a public hearing. The Corps holds public hearings for the purpose of obtaining public comments when that is the best means for understanding a wide variety of concerns from a diverse segment of the public.

Karen Kirk Adams
Chief, Permits & Enforcement Section
Regulatory Branch

SEE NEXT PAGE FOR
DETAILS OF EVALUATION FACTORS

The decision whether to issue a permit will be based on an evaluation of the probable impact of the proposed activity in the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which may reasonably accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered, including the cumulative effects thereof; among those are: conservation, economics, aesthetics, general environmental concerns, wetlands, cultural value, fish and wildlife values, flood hazards, flood plain value, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food production and, in general, the needs and welfare of the people.

Where the activity involves the discharge of dredged or fill material into waters of the United States or the transportation of dredged material for the purpose of disposing it in ocean waters, the evaluation of the impact of the activity in the public interest will also include application of the guidelines promulgated by the Administrator, U.S Environmental Protection Agency, under authority of Section 404(b) of the Clean Water Act, and/or Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 as amended.

Based on his initial review, the District Engineer has determined that little likelihood exists for the proposed work to impinge upon properties listed in, or eligible for listing in, the National Register of Historic Places, and no further consideration of the requirements of Section 106 of the National Historic Preservation Act of 1966, as amended, is necessary. This determination is based upon one or more of the following:

a. The permit area has been extensively modified by previous work.
b. The permit area has been recently created.
c. The proposed activity is of limited nature and scope.
d. Review of the latest published version of the National Register shows that no presence of registered properties listed as being eligible for inclusion therein are in the permit area or general vicinity.

Pursuant to the Endangered Species Act, the District Engineer is hereby requesting that the appropriate Federal Agency provide comments regarding the presence of and potential impacts to listed species or its critical habitat.

The initial determinations made herein will be reviewed in light of facts submitted in response to this notice.

The following authorizations have been applied for, or have been, or will be obtained:

(X) Permit, License or Assent from State.
(X) Permit from Local Wetland Agency or Conservation Commission.
(   ) Water Quality Certification in accordance with Section 401 of the Clean Water Act.

The States of Connecticut, Maine, Massachusetts, New Hampshire and Rhode Island have approved Coastal Zone Management Programs. Where applicable the applicant states that any proposed activity will comply with and will be conducted in a manner that is consistent with the approved Coastal Zone Management Program. By this Public Notice, we are requesting the State concurrence or objection to the applicant's consistency statement.

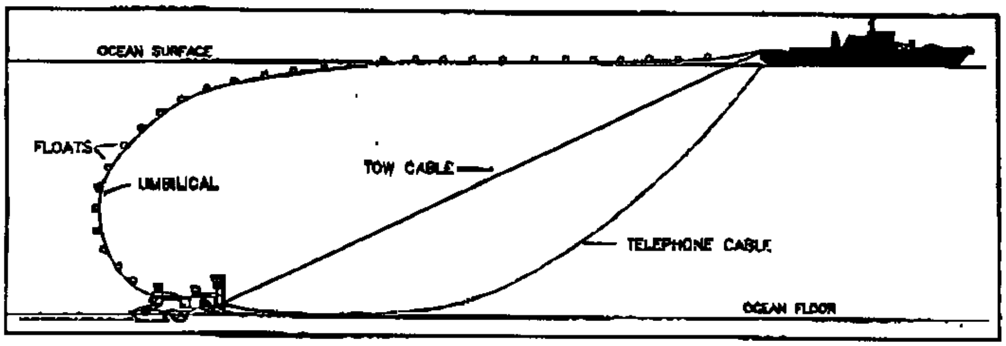
All comments will be considered a matter of public record. Copies of letters of objection will be forwarded to the applicant who will normally be requested to contact objectors directly in an effort to reach an understanding.

THIS NOTICE IS <u>NOT</u> AN AUTHORIZATION TO DO ANY WORK.

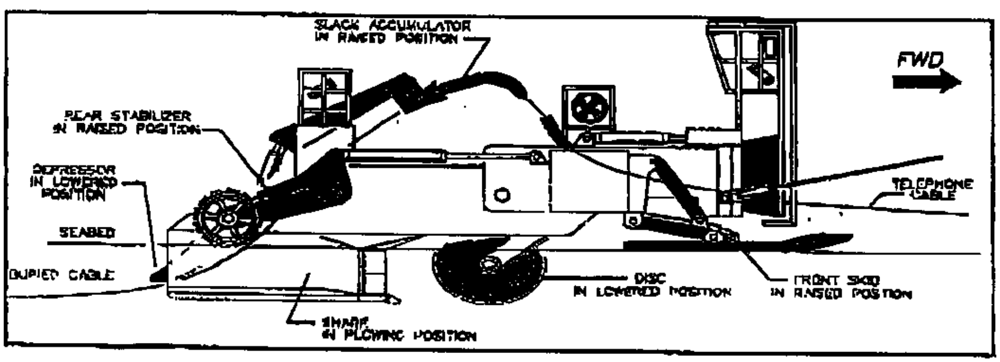
If you would prefer not to continue receiving public notices, please check here ( ) and return this portion of the public notice to: U.S. Army Corps of Engineers – New England District, ATTN: Regulatory Branch, 696 Virginia Road, Concord, MA 01742-2751.

NAME:
ADDRESS:

Hibernia Transatlantic Project
Submarine Cable Installation Figures



SeaPlow VII Burial Plowing Configuration



SeaPlow VII in Cable Burial Mode

Worldwide Telecom, Inc.
1510, 1066 West Hastings Street
Vancouver, British Columbia
Canada, V6E 3X1

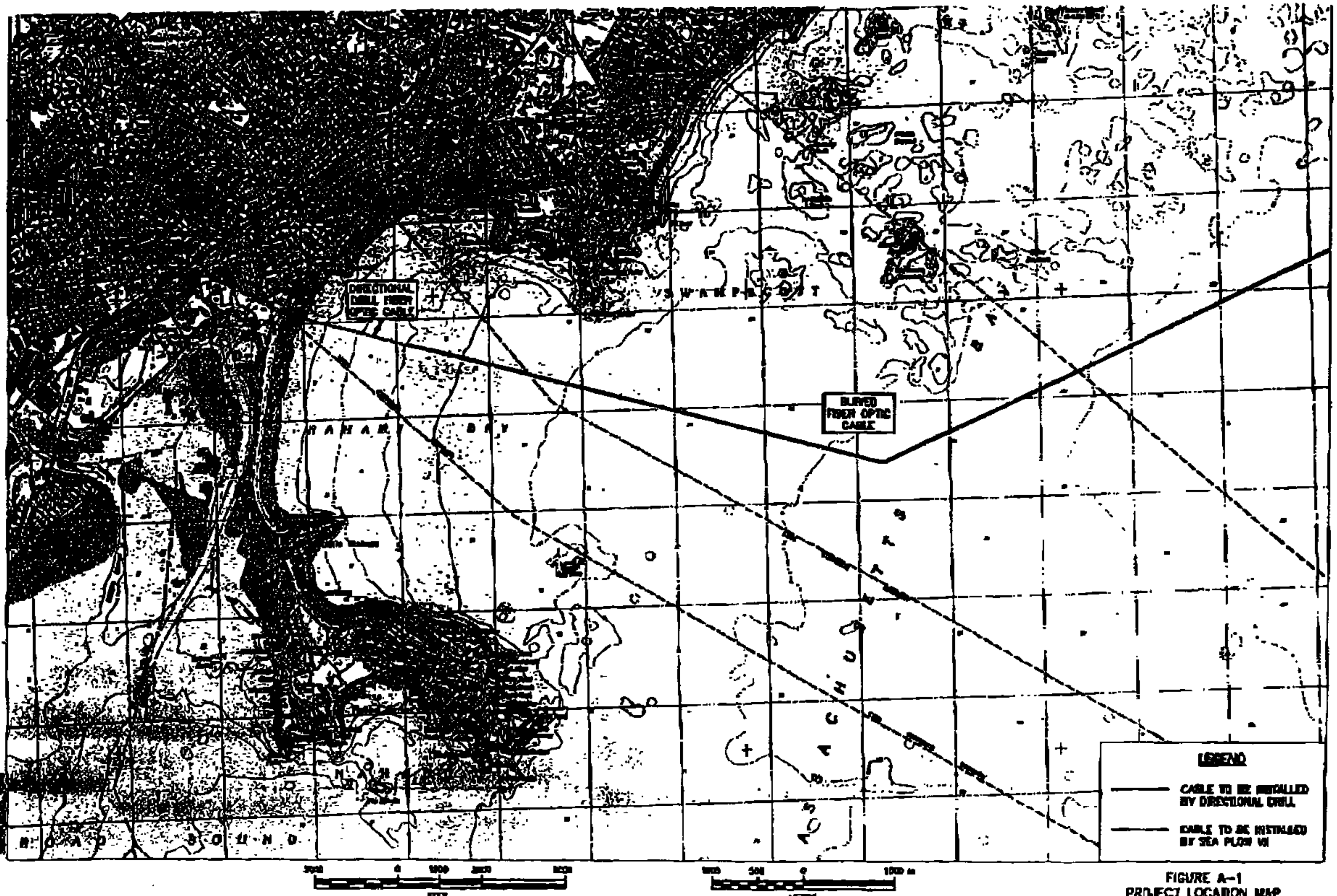


FIGURE A-1
PROJECT LOCATION MAP
HIBERNIA TRANSATLANTIC PROJECT

EARTH TECH

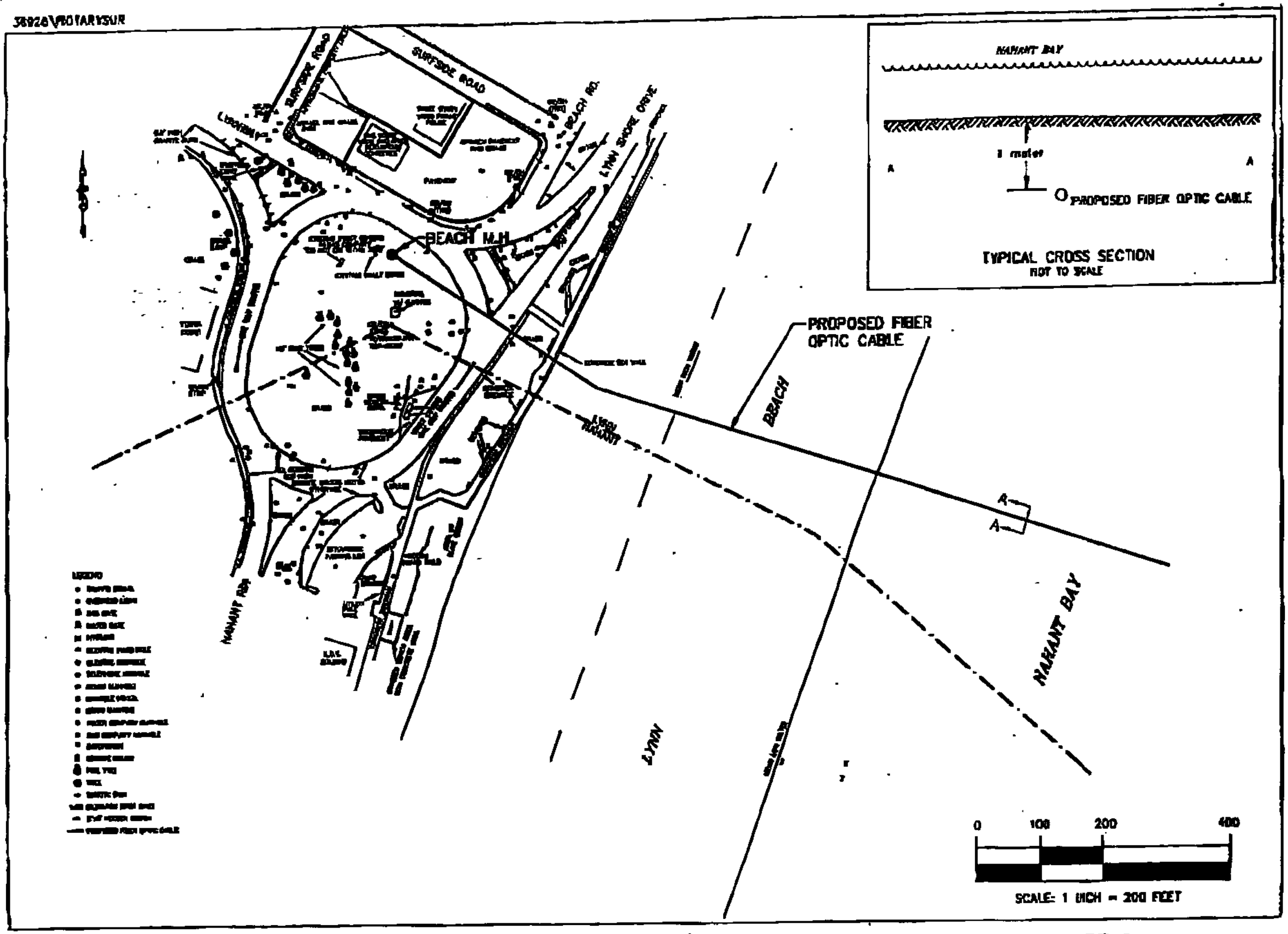


FIGURE 2-4
PLAN OF LANDING AREA
HIBERNIA TRANSATLANTIC PROJECT

EARTH TECH

FIGURE 2-1
PROJECT LOCATION MAP
HIBERNIA TRANSATLANTIC PROJECT

EARTH TECH

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO
ATTENTION OF

April 6, 2000

Regulatory Branch
CENAE-CO-R-199902369

Mr. Scott Lyons, Director
Worldwide Telecom, Inc.
150, 1066 West Hasting Street
Vancouver, British Columbia, Canada, V6E 3X1

Dear Mr. Lyons:

Enclosed are two copies of a Department of the Army permit authorizing the work described therein. Your signature is necessary to execute this permit. The authorized work cannot start until we receive a complete, signed copy of the permit. If the conditions are acceptable, please sign both copies and return one signed copy of the entire permit to us. A fee of $10.00/$100.00 is required. Please enclose a check made payable to "FAO New England District", and return it with the signed permit copy. Please ensure your address and social security number, or tax identification number for businesses, are on the check.

Please post the enclosed ENG form 4336 (i.e., Notice of Authorization) in a conspicuous location at the job site whenever work is ongoing. This permit requires you to notify us before beginning work so that we may inspect the project. Therefore, please complete and return the attached Work Start Notification Form(s) to this office no later than two weeks before the anticipated starting date. If the plans or construction methods (i.e., for work in our jurisdiction) need to be changed, please contact us immediately to discuss modification of your permit prior to undertaking these changes.

This permit is a limited authorization containing a specific set of conditions. Please read the permit thoroughly to familiarize yourself with those conditions, including any conditions contained on the attached state water quality certification. If a contractor does the work for you, both you and the contractor are responsible for ensuring that the work is done in compliance with the permit's terms and conditions, as any violations could result in civil or criminal penalties.

The Corps of Engineers has consulted with the National Marine Fisheries Service (NMFS) regarding the effects of your project on Essential Fish Habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act. NMFS provided EFH conservation recommendations, which we included in the attached special condition # 6. This condition will reduce impacts to EFH.

Finally, please note that the Department of the Army permit process does not supersede any other agency's jurisdiction. Hence, if other federal, state, and/or local agencies have jurisdiction over your project, you must receive all applicable permits before you may begin work.

The Corps of Engineers recently issued final regulations regarding an administrative appeals process for permit denials or proffered permits that you object to the terms and conditions of. A Notification of Applicant Options (NAO) form and flowchart are enclosed with this letter, which explains the appeals process and your options. The North Atlantic Division Office will hear all accepted appeals. However, in order to retain your right to appeal, should you intend to, you must respond to the attached NAO form within 60 days of this letter's date. Responses and questions regarding the Corps of Engineers appeals process should be directed to Ms. Christine Godfrey, Policy and Technical Support Section at (978) 318-8673 or at the above address.

If you have any questions regarding this correspondence, please contact (Mr.) Laurie H. Suda at (978) 318-8493, (800) 343-4789, or use (800) 363-4367 within Massachusetts.

Sincerely,

William F. Lawless, P.E.
Chief, Regulatory Branch
Construction/Operations Division

Enclosures

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

MAR 3 2000

William F. Lawless
Chief, Regulatory Branch
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Worldwide Telecom, Inc. Hibernia Fiber Optic Cable Project (Corps #99-2369)

Dear Mr. Lawless:

We have reviewed the public notice and associated application documents submitted by Worldwide Telecom, Inc. to install a high capacity fiber optic cable between Lynn, Massachusetts and Halifax, Nova Scotia. This cable project would be interconnected with a pending Halifax to Dublin, Ireland and Liverpool, England fiber optic project. The applicants proposed alternative would route the cable across the Gulf of Maine, through Wilkinson Basin and traverse approximately 17 miles of the Gerry E. Studds Stellwagen Bank Marine Sanctuary to the cable-landing site at Lynn Beach. The preferred alternative was chosen such that the entirety of the cable would be deployed in soft bottom sediments and therefore provide maximum avoidance of ledge out-croppings and rocky/cobble bottom habitat. We do not object to issuance of this permit provided that the permit is appropriately conditioned to minimize and avoid potential impacts to living marine resources.

The method of installation includes a combination of directional drilling and "sea-plow" technology. Directional drilling will be used to install the steel conduit and cable from the upland location in Lynn to the 5-meter water depth located approximately 1500 meters offshore. Directional drilling was incorporated into the project to avoid impacts to a nearshore eelgrass (*Zostera marina*) bed. Seaward of the directional drilled section, the cable will be installed with a sea-plow cable installation machine that is controlled from a surface cable ship. The plow process would temporarily displace a shallow wedge of the seabed (approximately 1 meter wide x 1.5 meters deep) and install the cable within the trench. The displaced soil would then immediately be returned to the trench to cover the cable. The cable installation would progress at a rate of approximately 0.5-1.0 knots. We recommend that post deployment surveys be conducted within 30 days following installation of the cable and again four years post installation in order to document that targeted depths of deployment were reached. Pending the results of the post deployment surveys, it may be necessary for NMFS to provide additional Essential Fish Habitat (EFH) or Endangered Species Act (ESA) conservation recommendations.

Worldwide Telecom, Inc. completed an EFH impact assessment which identified potential project impacts on a wide variety of federally managed species and their required habitats that are located along the cable route. The assessment analyzed minimization of aquatic impacts in association with the methods of installation, identification of important resource areas, specific physical bottom habitat characteristics and available fish life histories. In general, sedentary and slow-moving benthic organisms will be injured and killed during the cable installation and mobile benthic species are expected to avoid the direct impact by moving out of the way of the deployment. The EFH assessment concludes, and we concur, that installation of the fiber optic cable would adversely affect EFH. However, provided that the permit is conditioned to require burial of the cable to a minimum of 1.5 meters below the ocean bottom and directionally drilled out to the 5-meter contour interval, we can conclude that the impacts would only be only minimal and temporary in nature. We have no further EFH conservation recommendations.

Practically every northwest Atlantic endangered or threatened species of the sea turtle and marine mammal has been documented somewhere along the proposed cable laying route. Our initial concerns focused on the potential for ship strikes and entanglements during the cable deployment and marine mammal entanglements associated with non-buried sections of the cable. The applicants provided detailed information explaining how the slow deployment speeds (.5 to 1.0 knots) would reduce the potential for ship strikes and the proposed option to bury the entire cable 1.5 meters below the ocean bottom would avoid the potential for post deployment entanglements. Therefore, provided that the permit is conditioned to require burial of the cable and at a deployment speed no greater than 1.0 knots, we can conclude that this project is not likely to adversely affect endangered sea turtles or whales that may be present in the project location. Accordingly, further consultation pursuant to Section 7 of the Endangered Species Act will not be necessary. However, if project plans change or new information becomes available that would modify the basis for this determination, then consultation should be reinitiated.

The portion of the project proposed to traverse the Gerry E.Studds Stellwagen Bank National Marine Sanctuary would require an authorization from the National Ocean Service (NOS) of NOAA and review under the National Environmental Policy Act of 1969 (NEPA). The NOS is currently making a determination regarding what level of NEPA analysis will be required and will inform you of the decision in a separate letter. NMFS will continue to coordinate with the NOS and the applicant as needed in the review/preparation of the NEPA documents.

If you have any questions regarding this letter, please contact Eric Hutchins of our Habitat Conservation Division at (978) 281-9313.

Sincerely,

Patricia A. Kurkul
Regional Administrator

cc: Chris Mantzaris – F/NER4
Edward Lindelof – N/0RM2
Tom Bigford – F/HC2
David Webster – EPA (Boston)
Mike Bartlett – USFWS (Concord, NH)
Paul Diodati - MADMF (Boston)

File: MA-Lynn, Corps #99-2369
Worldwide Telecom, Inc.
Halifax to Lynn Cable

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
Silver Spring, Maryland 20910

September 10, 1999

John Murphy
TYCO Submarine Systems
60 Columbia Turnpike
Morristown, NJ 07960

Transmitted by Fax

Dear Mr. Murphy:

This letter is in reference to the recent correspondence between the National Marine Sanctuary Program (NMSP) Office and Hardeep Sidhu of Seafloor Systems International, Inc. regarding additional testing of the proposed Hibernia Transatlantic cable route. In that correspondence we suggested that Mr. Sidhu contact Dr. Page Valentine) to obtain United States Geological Survey (USGS) maps of the Stellwagen Bank area. Mr. Sidhu responded that he had done so.

The USGS has unpublished maps that can be obtained by contacting Dr. Valentine (508-457-2239), which Mr. Hardeep has not done. The maps are developed from data collected in 1994-1996 and use multi-beam imagery, which shows the seafloor in great detail. These maps were developed for all of the Stellwagen Bank National Marine Sanctuary (SBNMS or Sanctuary), the areas immediately surrounding SBNMS, and parts of Massachusetts Bay. These maps represent the best available information regarding the bottom seafloor with the SBNMS, and must be used in choosing any potential routes through the Sanctuary.

Furthermore, as you are aware, the NMSP is required to conduct an environmental analysis under the National Environmental Policy Act (NEPA) prior to issuing you any permit or other authorization to install fiber optic cable in SBNMS. This analysis must include discussion of reasonable alternatives, including no action and alternative routes. We would like to work with you on the alternatives that should be developed for the NEPA analysis, as they must be alternatives that are acceptable to NOAA.

Once you have examined the above-referenced USGS maps, please contact Ed Lindelof, Acting SBNMS Manager (301-713-3145 x131) or me (x152) to discuss the alternative analysis required under NEPA. Thank you for your continued cooperation.

Sincerely,

Helen M. Golde
National Permit Coordinator
National Marine Sanctuary Program

cc: H. Sidhu, Seafloor Surveys International, Inc.
J. Vaccaro, Earth Tech, Inc.
P. Phibbs, World Wide Telecon
E. Lindelof, A. Scmrcina, K. Van Dine, P. Auster, SBNMS
P. Valentine, USGS
G. Kelly, USACE
S. Thornton, NOAA/MSD
M. Weiss, S. Campbell, NOAA/GCOS

Faxed to JV.
9/21/99

tyco submarine systems ltd.

Marine Cable Engineering & Installation
Facsimile (Number of Pages 2)
DATE/TIME: 20 September 99 – 1900 USA EDT
To: Helen Golde, NOAA Marine Sanctuaries Division
Fax Number: +1-301-713-0404
Cc: John Vaccarro, Earth-Tech
Fax Number: +1-978-371-7889
Cc: Peter Phibbs, Worldwide Fiber Inc.
Fax Number: +1-604-681-0291
Cc: Don Hussong, Seafloor Surveys Inc.
Fax Number: +1-206-441-9308

From:
John Murphy
Senior Manager - Route Engineering
Patriots Plaza Room 2-168
60 Columbia Turnpike Building A
Morristown, New Jersey 07960
+1(973) 656-8292 +1(973) 656-8247 Fax
+1(908) 281-7041 (residence)
+1(973) 610-4284 (mobile)
jtmurphy@submarinesystems.com

Re: Hibernia Cable route in the vicinity of the Stellwagen Bank NMS

Dear Ms. Golde,

Thank you for your letter and fax dated 10 September regarding our investigation into available data for primary and alternate route considerations.

We would like to correct some inaccuracies in your letter. Though you state that we have not obtained any data from Dr. Valentine, we have in fact gathered digital data from Dr. Bill Scwab of the same office. Our surveyor has also obtained some unpublished information from Dr. Valentines' offices. This information was utilized in the completion of the Desk Top Study for this system which was published in July of this year.

Additional information was gathered from the geological laboratories of the University of Maine from Dr. Dan Belknap. This was to further assess buriable routes either through our primary route across the northern edge of Stellwagen Bank NMS or to an alternate routing we have selected around Jeffries Ledge which would avoid Stellwagen completely.

We are currently surveying both routes to provide alternatives as may be necessary for NEPA.

Should you have any questions, please feel free to call me.

Regards,

John T. Murphy

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
22 Bridge Street, Unit #1
Concord, New Hampshire 03301-4986

RE: Worldwide Fiber's Hibernia Project,
The Boston Landing - Lynn, MA
and coastal areas in the Gulf of Maine

September 27, 1999

Margaret Mills
Earth Tech
196 Baker Avenue
Concord, MA 01742

Dear Ms. Mills:

I have reviewed your request for information on endangered and threatened species and their habitats for the above-referenced project. My comments are provided in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Only one federally-listed species under the jurisdiction of the U.S. Fish and Wildlife Service occurs within the project area: the roseate tern (*Sterna dougallii*). In addition to the endangered roseate tern, there are several marine mammals in the Gulf of Maine such as the hump-backed whale (*Megaptera novaeangliae*), northern right whale (*Eubalaena glacialis*), and several sea turtle species that are federally-endangered. For more information on marine mammals and sea turtles, please contact the National Marine Fisheries Service, Northeast Region, One Blackburn Drive, Gloucester, MA 01930.

The roseate tern is a long-distance migrant, found along the Northeast Atlantic Coast during the breeding season from late April to mid-September. Nesting sites of the northeastern population occur from Long Island, New York to Cape Cod and Plymouth, Massachusetts, as well as along the coast of Maine and Nova Scotia. For maps of nesting sites within the Northeast, please see the enclosures (from the Roseate Tern Recovery Plan, Northeastern Population, U.S. Fish and Wildlife Service, 1998).

The roseate tern is an exclusively marine species. It usually breeds on small islands, but occasionally breeds along spits or peninsulas along barrier beaches. All nesting sites in the northeast are found in association with colonies of common terns (*Sterna hirundo*). During the primary breeding season (May to August), roseate terns forage on small schooling fish in relatively shallow waters. Some birds have been found to forage regularly up to 25 km away from the colony sites. During August and September, family groups disperse from breeding colonies and feed in preparation for southward migration. All roseate terns in the Northeastern Atlantic population gather in premigratory staging areas at inlets and barrier beaches from New York to the Gulf of Maine during this period. During this premigratory period, birds feed offshore, but return daily to shore to rest and roost.

There are no known roseate tern nesting sites near the project's land fall in Cape Ann, Massachusetts, and it is unlikely that the cable burying procedures, as described in your project, will affect the roseate tern offshore. However, we request that you advise this office if offshore cable burying work is planned in the Gulf of Maine for the months of August and September, when roseate terns will be present prior to their southward migration.

Thank you for your cooperation and please call Sylvia Schmidt at 603-225-1411 if we can be of further assistance.

Sincerely yours,

Sylvia L Schmidt

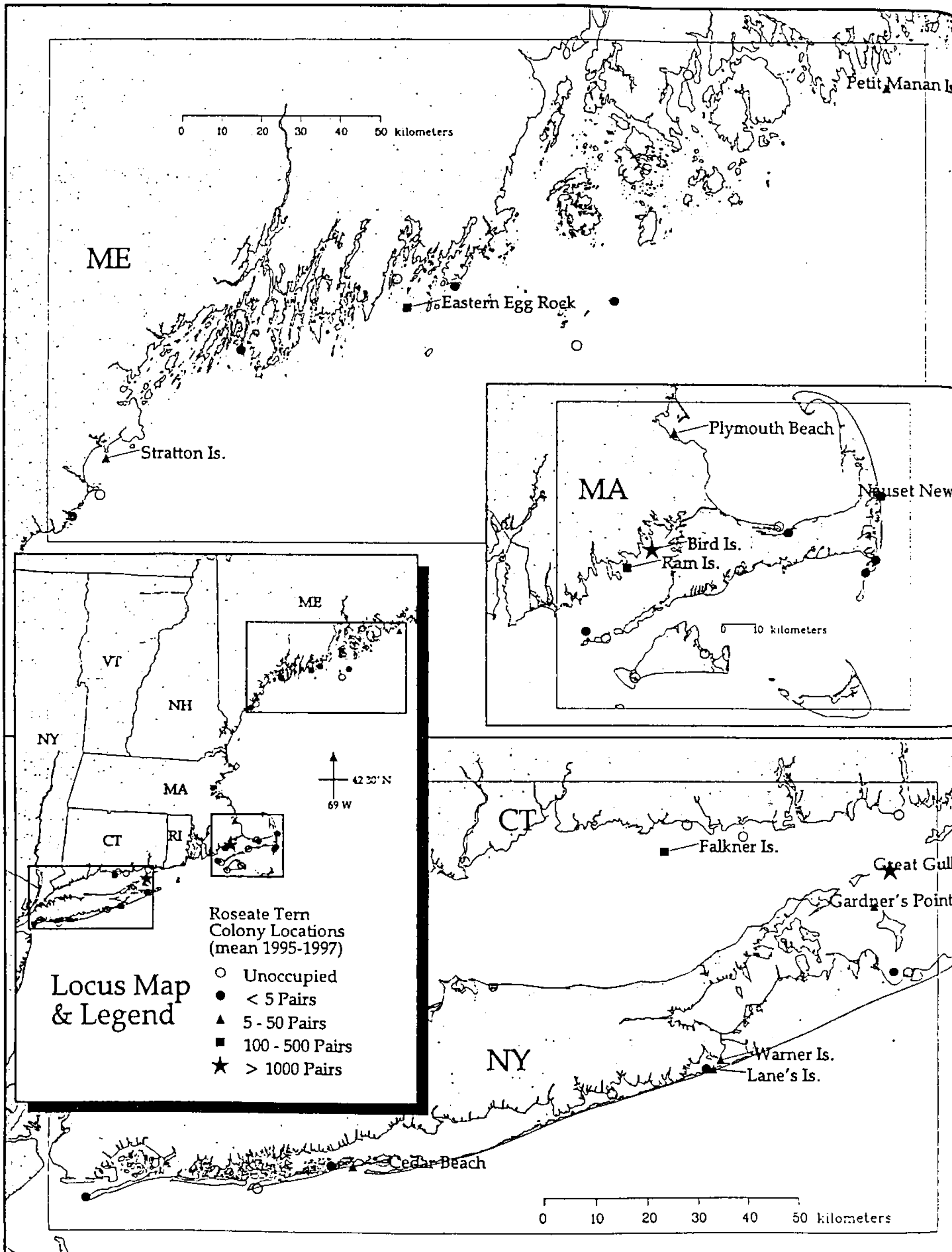
for Michael J. Amaral
Senior Endangered Species Biologist
New England Field Office

Enclosures:

Figure 2. Roseate tern nesting sites in the Northeast from 1977-1988
Figure 3. Roseate tern nesting sites in the Northeast from 1988-1997

Figure 2. Roseate tern nesting sites in the northeastern U.S. and Canada occupied one or more years, 1977-1988.

Figure 3. Nesting sites used by roseate terns in the northeastern U.S., 1989-1997.



196 Baker Avenue, Concord, Massachusetts 01742

RECEIVED
OCT 29 1999

October 20, 1999

Helen Golde
National Oceanic & Atmospheric Administration
1305 East-West Highway, 11th Floor
Silver Spring, MD 20910

Subject: **Worldwide Telecom Cable Project**

Telephone
978.371.4000
Facsimile
978.371.2468

Dear Ms. Golde;

I am forwarding a copy of the Certificate of the Secretary of Environmental Affairs on the Environmental Notification Form for the Worldwide Telecom Hibernia Cable Project for your files.

If you have any questions regarding this matter please do not hesitate to call me at 978-371-4234.

Very truly yours,
Earth Tech, Inc.

Matt Morais

Enclosure

September 28, 1999

Executive Office of
Environmental Affairs
100 Cambridge Street
Boston, MA 02202

RE: Lynn
Hibernia Fiber-Optic
ENF/EOEA #12026

Attn: MEPA Unit

Dear Secretary Durand:

The Department of Environmental Protection Northeast Regional Office has reviewed the Environmental Notification Form submitted by Worldwide Fiber, Inc. to construct a Trans-Atlantic fiber optics telecommunication cable that will be partially located within Massachusetts jurisdiction (EOEA #12026).

The project proponent is advised that any issues concerning the installation of the fiber-optic cable along the coastline of Lynn will be addressed in the review of the Notice of Intent, 401 Water Quality Certification, and Chapter 91 License. The project proponent should indicate in its applications how much dredging will be required for the project.

Although the Department is not aware of any confirmed active 21E sites along the proposed land-side of the route (along the Lynnway and Commercial Street in Lynn), if any of the proposed trenching operation occurs in the general vicinity of a gas station or other business where hazardous materials have been used or stored over a period of time (auto repair shop, electro-plating operation, etc.), there is a likelihood that localized soil contamination has occurred. If applicable, the location of these sites should be carefully reviewed prior to commencing the project. The project proponent is advised that removing and disposing of contaminated soil, pumping of contaminated groundwater, or working in contaminated media must be done under the provisions of MGL c.21E/21C and OSHA. Failure to obtain the necessary permits under these provisions beforehand may result in considerable delay of the project as well as administrative penalties.

The DEP Northeast Regional Office appreciates the opportunity to comment on this proposed project. Please contact David Kennedy at (978) 661-7776 for further information on the waterways issues. If you have any general questions regarding these comments, please contact David Shakespeare, MEPA Review Coordinator at (978) 661-7797.

Sincerely,

John Felix,
Deputy Regional Director

cc: Dave Murphy, DEP/O&P Boston
David Kennedy, DEP/BRP NERO
Steve Johnson, DEP/BWSC NERO

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street, Boston, MA 02202

ARGEO PAUL CELLUCCI
GOVERNOR

JANE SWIFT
LIEUTENANT GOVERNOR

BOB DURAND
SECRETARY

Tel. (617) 727-9800
Fax (617) 727-2754
http://www.magnet.state.ma.us/envir

October 8, 1999

CERTIFICATE OF THE SECRETARY OF ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Hibernia Fibre-Optic Telecommunication System
PROJECT MUNICIPALITY	: Lynn, Beverly, Gloucester, Manchester, Marblehead, Salem, and Swampscott
PROJECT WATERSHED	: North Coastal
EOEA NUMBER	: 12026
PROJECT PROPONENT	: Worldwide Fiber, Inc.
DATE NOTICED IN MONITOR	: September 8, 1999

Pursuant to the Massachusetts Environmental Policy Act (M.G.L. c. 30, ss. 61-62H) and Section 11.06 of the MEPA regulations (301 CMR 11.00), I hereby determine that this project **does not require** the preparation of an Environmental Impact Report.

According to the Environmental Notification Form (ENF), the project involves construction of a high capacity fiber optic connection between cities in North America and Europe. The cable route from Europe makes landfall in Halifax, Nova Scotia. After crossing the Gulf of Maine, it uses a coastal route through the offshore waters of Beverly, Gloucester, Manchester, Marblehead, Salem, Swampscott, and Lynn, to an upland facility in Lynn. On land it will cross the MDC Lynn Beach Reservation Park, the Lynnway Rotary, the Lynnway, and Commercial Street to a cable station on a one-acre site at 83 Commercial Street in Lynn.

The project is subject to review pursuant to Section 11.03 (3)(b)1a, e & f of the MEPA regulations because it involves alteration of a coastal bank, alteration of more than one-half acre of wetlands, and construction of a structure in a velocity zone. It requires a Chapter 91 Waterways License, and Water Quality Certification from the Department of Environmental

Protection (DEP), Federal Consistency Review from the Coastal Zone Management (CZM) office, an easement or permit from the Metropolitan District Commission (MDC), compliance with Article 97 of the State Constitution, and Orders of Conditions from eight Conservation Commissions. Because the proponent is not seeking financial assistance from the Commonwealth, MEPA jurisdiction is limited to those aspects of the project that are within the subject matter of the state permits.

The ocean routes cross two ocean sanctuaries and the Stellwagen Bank National Marine Sanctuary. The proponent proposes to use a "sea plow" technology that will bury the cable approximately 1.5 meters below the ocean floor. The Department of Environmental Management and NOAA will provide input to the Waterways and COE permitting process. Marine rare and endangered mammals will also be considered in the process. I encourage the proponent to continue discussions with both agencies, to ensure that all applicable regulatory standards will be met.

The routes are being surveyed to minimize impacts to contaminated soils, fisheries, and archaeological resources. I ask that the results of those efforts be provided to this office for completion of the file.

Much of the inland route involves construction within floodplains, and may involve 21 E sites or potential archaeological sites. The DEP and MHC will be addressing these concerns.

The terminal building at 83 Commercial Street in Lynn will occupy approximately one half acre of the one acre site. Other communication carriers will be responsible for constructing the necessary connections to that facility. Details of the communication connections by other parties should be filed as Notices of Project Change for this project with the MEPA office.

Based on a review of the information provided by the proponent and after consultation with relevant public agencies, I find that the potential impacts of the project are not significant enough to warrant preparation of an Environmental Impact Report and can be addressed in the permitting process. No further MEPA review is required. The proponent should continue to work with the permitting agencies to finalize the routes and appropriate mitigation measures.

October 8, 1999
DATE

Jay Wickersham for
Bob Durand

Comments received : DEP - 9/28/99
DEM - 9/15, & 27/99
MCZM - 9/27/99
MHC - 9/27/99

BD/DES/ds

D S

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

RECEIVED
OCT 0 4 1999
MEPA

September 27, 1999

Secretary Bob Durand
Executive Office of Environmental Affairs
100 Cambridge Street
Boston, MA 02202

ATTN: MEPA Unit

RE: Hibernia Fiber-Optic Telecommunication System Project, Lynn, EOEA #12026, MHC #RC.24669

Dear Secretary Durand:

Staff of the Massachusetts Historical Commission have reviewed the Environmental Notification Form for the proposed project referenced above. MHC understands that the project involves the installation of a fiber-optic cable beneath the seabed within Massachusetts waters. The upland portion of the cable will be installed within existing roadways except for a section that will traverse the MDC park between Lynn Beach and the Lynnway Rotary.

The off-road segment of the upland portion of the project route traverses an area that is archaeologically sensitive based on its proximity to recorded archaeological sites and favorable environmental features. Review of MHC's Inventory of the Historic and Archaeological Assets of the Commonwealth indicates that an archaeological site (MHC site #19-ES-623) associated with the Native American settlement of the Lynn area is located a short distance from the proposed route of the fiber-optic cable. Proximity to known archaeological sites is a strong indication that an area is likely to contain archaeological resources. Several sites including habitation areas, shell middens, and unmarked burials have been recorded along the coast of Nahant Bay, where a wide variety of coastal, marine, estuarine, and upland resources attracted Native American settlement over thousands of years. MHC requests that an intensive (locational) archaeological survey (950 CMR 70) be conducted for the proposed off-road upland segment of the cable route. The purpose of the intensive survey, which is conducted under a permit from the State Archaeologist (950 CMR 70) is to locate and identify archaeological sites that may be located within project impact areas.

The ENF notes (Schedule 10) that an archaeological survey of the undersea portion of the cable installation will be conducted. MHC concurs with this plan and requests that an intensive (locational) archaeological survey also be conducted for the undersea portion of this project. The purpose of the survey, which is conducted under permits from the State Archaeologist (950 CMR 70) and the Board of Underwater Archaeological Resources (BUAR) (31 CMR 2), is to locate and identify archaeological resources within underwater project impact areas.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800), Massachusetts General Laws, Chapter 9, Sections 26-27C, as

220 Morrissey Boulevard, Boston, Massachusetts 02125 · (617) 727-8470
Fax: (617) 727-5128 · TDD: 1-800-392-6090
www.state.ma.us/sec/mhc

amended by Chapter 254 of the Acts of 1988 (950 CMR 70-71), and MEPA. If you have any questions, please feel free to contact Eric Johnson of my staff.

Sincerely,

Brona Simon

Brona Simon
State Archaeologist
Deputy State Historic Preservation Officer
Massachusetts Historical Commission

xc: Matt Morais, Earth Tech
Scott Lyons, Worldwide Fiber (USA), Inc.
Victor Mastone, BUAR
Karen Kirk Adams, USACOE-NED-Regulatory
Kate Atwood, USACOE-NED
Massachusetts CZM
DEP, Northeast Regional Office
Thomas Mahlstedt, MDC
Lynn Historical Commission

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
100 CAMBRIDGE STREET. BOSTON, MA 02202
(617) 626-1200 FAX: (617) 626-1240

05

RECEIVED
SEP 29 1999
MEPA

MEMORANDUM

To: Bob Durand, Secretary, EOEA
Attn: Dave Shepardson, MEPA Unit
From: Tom Skinner, Director, MCZM TSm
Date: September 29, 1999
Re: EOEA # 12026, Hibernia Fibre-Optic Telecommunications System Project, Lynn

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The Massachusetts Coastal Zone Management (MCZM) Office has completed its review of the above-referenced Environmental Notification Form (ENF), noticed in the Environmental Monitor dated September 8, 1999, and recommends the preparation of an Environmental Impact Report.

The proposed project entails use of a "sea plow" technology to bury a Halifax-to-Boston segment of a fibre-optic telecommunications cable about 1.5 meters below the ocean floor. The proposed route will take the cable through the waters of several North Shore towns, through Massachusetts Ocean Sanctuaries, and through a section of the Stellwagen Bank Marine Sanctuary. Federal regulations at 15 CFR 922, Subpart M require authorization by the Sanctuary for installation and operation of the cable within the Sanctuary.

In the past, MCZM has commented on the construction of pipelines and has requested the pipeline be buried at least six feet below the ocean floor, where technologically feasible, to avoid conflicts with fisheries and other gear. While the difference below the sea floor may be minor, we would like to encourage the cable be buried as deep as possible to prevent the cable from obstructing fishing operations and protecting the cable from damage due to trawling doors used in fishing operations. In addition, for many years AT&T has provided the fishing industry with educational material on cable location, what to do, and who to call if a vessel snags a cable. That same educational program should be provided to area fishermen by the project proponent.

The route of this cable will be through Essential Fish Habitat (EFH). The proponent should consult with the National Marine Fisheries Service on minimizing any impact to such habitat. MCZM is particularly concerned about the effects of trenching effects on the water column, marine water quality, and flora and fauna.

The proposed route is through critical habitat for the endangered right whale. MCZM requests that the applicant detail methods of avoiding entanglements with this and other marine mammals as the cable is laid and with exposed portions of the cable after it is on the ocean bottom.

During construction, the project will create noise. This noise and its impact should be evaluated in relation to marine mammals in the area during construction. In addition, portions of the cable may create strumming noise (lateral movement of the cable on the seafloor due to ocean currents). This noise, should it occur, may affect marine animals and should be evaluated.

The project will generate a substantial amount of data on surface geology of the final route and alternate routes. MCZM requests that these data be made available to the USGS, NMFS and the Commonwealth.

A structure/facility will be needed to house the cable as is comes ashore. This should be flood proof and not cause any coastal erosion.

The proposed project may be subject to MCZM federal consistency review. For further information on this process, please contact Jane W. Mead, MCZM Project Review Coordinator, at 617-626-1219.

TWS/JEP

cc: Greg Carrafiello, Section Chief,
Waterways Regulation Program, Massachusetts DEP
Jim Sprague, Section Chief,
Northeast Regional Office, Massachusetts DEP
Andrea Cooper,
MCZM North Shore Regional Coordinator

To: Dave Shepardson@MEPA@EOEA
From: Mike Gildesgame@RC@DEM Boston
Cc: Peter Webber@Admin@DEM Boston,Martin Suuberg@RC@DEM Boston, Richard Thibedeau@RC@DEM Boston,James Sprague@brp ww@DEP NERO, Jane Mead@CZM@EOEA
Subject: EOEA #12026
Attachment:
Date: 9/27/99 4:19 PM

I am providing preliminary comments on the proposed Hibernia Fibre-Optic Telecommunications system project, EOEA #12026.

The proposal would install fibre optic cable from Europe, across the nothern point of the Stellwagen National Marine Sanctuary, across portions of the North Shore and South Essex Ocean Sanctuaries, and terminate in Lynn. The last portion of the project, where the cable would come ashore in Lynn, would be south of the South Essex Ocean Sanctuary boundary.

The project proposes to use "sea plow" technology to bury the cable about 1.5 meters below the ocean floor. This technology, as described, involves no dredge spoils and purports to have minimal impacts to the seabed and ecology.

Because the project is subject to chapter 91, the Ocean Sanctuaries Program will comment more formally when we receive and review the completed ch. 91 application from DEP; however, I am concerned about the impacts to the seabed and ecology of the area affected by the plow vehicle and plow itself. I will also consult with DMF and CZM regarding any concerns they may have regarding this proposal. I also would like clarification if DPU approval is required for this project.

While "the laying of cables approved by the department of public utilities" is specifically approved by the Ocean Sanctuaries Act, we will need to determine if the specific technology will constitute "exploitation, development, or activity that would significantly alter or otherwise endanger the ecology... of the ocean, the seabed, or subsoil thereof...".

Thank you.

To: Dave Shepardson@MEPA@EOEA
From: Debbie L. Graham@RC@DEM Boston
Cc: Mike Gildesgame@RC@DEM Boston
Subject: re: MEPA meetings Lynn CABLE
Attachment:
Date: 9/15/99 2:34 PM

Hi Dave, I'm "retiring" from DEM this week but passed your email along to Mike Gildesgame who hopes to send someone on the 21st.

S 16 of the Ocean Sanctuaries Act lists cables as permitted as along as approved by the Dept. of Public Utilities. I asked Matt at Earth Tech to find out whether they need DPU approval for this type of cable.

It's been nice working with you....Bye

1 October 1999

Margaret A. Mills
Earth Tech
196 Baker Ave.
Concord, MA 01742

Re: Worldwide Fiber's Hibernia Project - The Boston Landing
Lynn, MA
NHESP File: 99-5700

Dear Ms. Mills,

Thank you for contacting the Natural Heritage and Endangered Species Program for information regarding state-protected rare species in the vicinity of the project referred to above.

At this time we are not aware of any rare plants or animals or exemplary natural communities that would be adversely affected by the proposed project.

This review concerns only rare species of plants and animals and ecologically significant natural communities for which the Program maintains site-specific records. This review does not rule out the possibility that more common wildlife or vegetation might be adversely affected by the project, especially if it will modify currently undeveloped areas. Should project plans change, or new rare species information become available, this evaluation may be reconsidered.

Please call me at (508) 792-7270 x165 if you have any questions.

Sincerely,

Hanni Dinkeloo
Endangered Species Counsel

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
100 CAMBRIDGE STREET, BOSTON, MA 02202
(617) 626-1200 FAX (617) 626-1240

March 27, 2000

Matt Morais
Earth Tech
196 Baker Avenue
Concord, MA 01742

RE: Federal Consistency Certification: Worldwide Telecom Hibernia Project; Lynn

Dear Mr. Morais:

The Massachusetts Coastal Zone Management (MCZM) office has completed its review of the proposed project to install a fiber optic cable beneath the seabed within Massachusetts' waters.

We concur with your certification and find that the activity as proposed is consistent with the MCZM enforceable program policies.

If the above-referenced proposal, which has received this concurrence from MCZM, is modified in any manner or is noted to be having effects on the coastal zone or its uses that are substantially different than originally proposed, please submit an explanation of the nature of the change to this Office pursuant to 301 CMR 21.17 and 15 CFR 930.66.

Thank you for your cooperation with MCZM.

Sincerely,

for Thomas W. Skinner
Director

TWS/JEP

CC: Karen Kirk Adams, Chief Regulatory Branch, US Army Corps of Engineers
James Sprague, Section Chief Northeast Regional Office, MA DEP
Greg Carrafiello, Section Chief Waterways Program, MA DEP
Andrea Cooper MCZM's Northshore Regional Coordinator

→ Scott - some good comments

(2)

facsimile transmittal

2 3 REC'D

To:	William Douros, MBNMS	Fax:	647-4250
From:	Martha Diehl	Date:	08/23/99
Re:	Comments on Cable Routing	Pages:	3

Mr. Douros:

My name is Martha Diehl. I am a fourth-generation resident of the south coast. I retired in May of this year from my position as Master of the Cable Ship Global Mariner, for Tyco, Inc. During my 15 or so years with TCSC/Tyco, I have installed and/or repaired literally thousands of kilometers of buried telephone cable all over the world.

I find that I am concerned about the installation of buried cable in my neighborhood. I would like to be sure that there are good, realistic questions and answers throughout the process of deciding cable routes and handling. In my experience this hands-on perspective is often not available during the planning stages, and just this once I'd like to help fill in that gap.

Some samples of the kinds of questions that I think should be addressed would include:

1. Discuss the impact of launch/recovery/damaged ROV operations on our environment. This isn't MBARI, and the vehicles are all hydraulic. Given the substrate and the sea conditions, they will be roughly used. In my experience, rocks are almost always harder that ROV's. There will be malfunctions. Hydraulic fuel will leak, and burial will be non-continuous. Retro-burial will not be able to fill in the gaps if the bottom is not cooperative. Rock-dumping is expensive and messy. What is anticipated in this regard, and is it okay with the Sanctuary?

2. Cables almost always require repair. Buried cables are harder to get to, and repair operations include digging up enough of the cable to fix any faults. This is a very low tech process, which involves dragging massive steel hooks across the cable track

until one catches it. This is not without environmental impact. Have you had a chance to discuss repair plans with the installation people? Often they are not very involved with the details of such operations, since they are managed by different people.

2

I could write more, but perhaps it would be better to speak with you and find out if these thoughts are of use. If so, I would be glad to do whatever you suggest in order to help us reach a good, well considered conclusion. Please call me if you would like to explore this. As a retired person, I am pretty much at your disposal! In addition, I am not unknown in the industry, which might also be useful in negotiations.

I'm including the brief version of my CV, for the sake of credibility.

Best regards,

Martha Diehl

2

Martha V. Diehl
Garrapata Trout Farm
35811 Hwy 1
Monterey, CA 94940
Phone: 831-625-9621
Fax: 831-625-1468

SUMMARY OF QUALIFICATIONS

Martha V. Diehl
Master Mariner

I graduated with honors from the United States Merchant Marine Academy in 1979 with a Third Mate's license and a B.S. degree in Marine Transportation. I sailed as a deck officer on black oil tankers, general cargo ships, and special product carriers until 1983, when I joined the Cable Ship Long Lines and began work for Transoceanic Cable Ship Company (now TYCO Submarine Systems). I have been employed by TYCO continually since then, sailing as Master first in 1989 and then continually since 1992 as permanent Master aboard the Global Mariner.

I joined the Long Lines in 1983. At that time the vessel was engaged not only in support of the existing coaxial cable(ACMA standby/ Wilmington N.C.) but in the initial testing and development of fiber cable and the supporting technology. As a junior officer I participated in numerous repairs, trials, and installations. I was aboard the CS Long Lines for the AT&T Optican testing, and have been actively involved in system installation and repair since then (chronology available upon request).

This has lead to familiarity with navigation technology to survey quality accuracy, as well as training in both conventional shiphandling and DP operation. I also have had experience in operations involving multiple ships and remotely operated vehicles, specifically SCARAB II and IV and SeaPlowVII as well as the Oceaneering SMD Seabed Tractor and various burial/inspection/rock dumping platforms of opportunity in the North Sea.

Most recently (Summer/98) I was in command of the Global Mariner for the AC1 SegA5 installation, which included 800km of burial using SPVII and 13 pipeline crossings. This section of AC1 was completed successfully and on schedule.

I retired from sailing as of May 1999, with 20 years service.

MARINE LICENSES

Master, Steam and Motor Vessels of Any Gross Tons Upon Oceans
Radar Observer, Unlimited
STCW Certificate - Master
GMDSS Operator (FCC)

2/3

Appendix B

Technical Cable Specifications

tyco submarine systems ltd.	**Simplex Technologies Inc.** **Fax Cover Sheet**
TO: Paul Hansen	FROM: Timothy R. Malloy
COMPANY: 360Networks	DEPARTMENT: Program Mgmt.
DEPARTMENT:	EXTENSION: 497
FAX NUMBER: (604) 648-7794	DATE: 5/2/00
SUBJECT: MSDS	NO. of PAGES: 25 (Including This Sheet)

A tyco INTERNATIONAL LTD. COMPANY

COMMENTS:

Paul,

Attached are the Material Safety Data Sheets for the following materials:

1. Loose Tube Gel MASTER GEL
2. Waterblock (polycin and vorite)
3. Armoring Tar MIX 46
4. Keystone CALCIUM CARBONATE

Please let me know if you have any questions.

Thanks,

Tim Malloy

Mailing Address:
Simplex Technologies Inc.
P.O. Box 479
Portsmouth, NH 03802-0479
- Phone: 603/436.6100

Shipping Address:
Simplex Technologies Inc.
2073 Woodbury Ave.
Newington, NH 03801-2875
- Marketing Fax: 603/436-0126

Master Adhesives, Inc.
996-A Norcross Ind. Ct.
Norcross GA 30071

Telephone (770)447-5025
Fax (770)447-5026

Material Safety Data Sheet

Section I – Product Identification

IDENTITY (as used on labels)	**Mastergel R-1795**
CHEMICAL NAME AND SYNONYMS	Optical Fiber Cable Filling Compound
DATE PREPARED	01/01/98

This information is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, expressed or implied, with respect to such information, and we assume no liability resulting from its use. Users are responsible for verifying this data under their own operating conditions to determine whether this product is suitable for their particular purposes and they assume all risks of their use, handling, and disposal of the product.

Section II - Hazardous Ingredients

Hazardous components	CAS #	%	TLV(units)
NONE			

Section III - Physical/Chemical Characteristics

BOILING POINT	N/A	SPECIFIC GRAVITY	0.89
VAPOR PRESSURE	unknown	MELTING POINT	N/A
VAPOR DENSITY	N/A	EVAPORATION RATE	N/A

SOLUBILITY IN WATER	negligible
APPEARANCE AND ODOR	colorless to light yellow - bland

Master Adhesives, Inc.
996-A Norcross Ind. Ct.
Norcross GA 30071

Telephone (770)447-5025
Fax (770)447-5026

Section IV - Fire and Explosion Hazard Data

FLASH POINT(METHOD USED)	400°F ASTM D-93-79
FLAMMABLE LIMITS	N/A
UPPER EXPLOSION LIMIT (UEL)	N/A
LOWER EXPLOSION LIMIT (LEL)	N/A
EXTINGUISHING MEDIA	Dry chemical, carbon dioxide, foam or water fog
SPECIAL FIRE FIGHTING PROCEDURES	None
UNUSUAL FIRE AND EXPLOSION HAZARDS	None

Section V - Reactivity Data

CHEMICAL STABILITY	Stable
INCOMPATIBILITY (Materials to Avoid)	unknown
HAZARDOUS DECOMPOSITION OR BYPRODUCTS	None
HAZARDOUS POLYMERIZATION	Will not occur

Section VI - Health Hazard Data

ROUTES OF ENTRY	Inhalation:	Use adequate ventilation
	Skin:	Wash with soap and water
	Ingestion:	Non-toxic
HEALTH HAZARDS	Eye contact:	None
	Skin contact:	None
	Inhalation:	None

Master Adhesives, Inc.
996-A Norcross Ind. Ct.
Norcross GA 30071

Telephone (770)447-5025
Fax (770)447-5026

CARCINOGENITY	NTP?	No
	IARC Monographs?	No
	OSHA Regulated?	No

SIGNS AND SYMPTOMS OF EXPOSURE — None

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE — unknown

EMERGENCY AND FIRST AID PROCEDURES

Eye contact - Flush eyes immediately with large amount of water.

Skin contact - Wash skin with soap and water.

Section VII - Precautions for Safe Handling and Use

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Dike and absorb spill with inert materials (dry sand, earth, etc.) and transfer to suitable containers for disposal.

WASTE DISPOSAL METHOD

Land fill in closed containers according to local, state, and federal regulations.

Section VIII - Control Measures

RESPIRATORY PROTECTION (specify type)	None
VENTILATION	Local exhaust
PROTECTIVE GLOVES	as required
EYE PROTECTION	as required
OTHER PROTECTIVE CLOTHING OR EQUIPMENT	None
WORK/HYGIENIC PRACTICES	Wash hands with soap and water before eating

SX 071

POLYCIN® 934 M-4

Page: 1
16 Sections Printed:03/04/94

original: 11/11/93
revised: 11/11/93

MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

Manufacturer: CasChem, Inc.
40 Avenue A
Bayonne, NJ 07002

Information and Emergency Phone during business hours: 1-800CASCHEM

For use only in the event of chemical emergencies involving a spill, leak, fire, or accident with this material:
Call CHEMTREC 800 424-9300

Trade Name..........: POLYCIN® 934 M-4
Chemical Name.......: Mixture - Proprietary
Synonyms............:
....................:
....................:
CAS #...............: Mixture
Chemical Family.....: Polyol
Product Code........: 72064
Product Use.........: Potting Compound/Encapsulant
PIN#................:
WHMIS Class.........: Not established

SECTION 2. COMPOSITION/INFORMATION ON COMPONENTS

COMPONENTS	CAS #	WEIGHT %
** Trade Secret **		

SECTION 3. HAZARDS IDENTIFICATION

Emergency Overview:
Clear yellow-amber liquid with a mild odor.
Material presents little or no immediate significant hazard if spilled. This material presents no unusual hazard if involved in a fire.

Breathing:
Single exposure to vapors or mist is not likely to be hazardous.

Skin Contact:
Prolonged or repeated skin contact may cause skin irritation.

Eye Contact:
Contact with eyes may cause slight eye irritation.

Swallowing:
May be harmful if swallowed.

continued ...

N/A = Not Available

SECTION 3. HAZARDS IDENTIFICATION ... continued

Long Term Health Effects:
Not known.

Conditions Aggravated By Exposure:
Not known.

SECTION 4. FIRST AID MEASURES

Breathing:
No specific treatment is necessary since the material is not likely to be hazardous by inhalation. If exposed to excessive levels of vapors or mists, remove to fresh air and get medical attention if cough or other symptoms develop.

Skin:
Wash with soap and water. Get medical attention if irritation develops or persists.

Eye:
Immediately flush eyes with plenty of water for at least 15 minutes, holding eyelids apart. Get medical attention if irritation or other symptoms occur.

Swallowing:
Dilute with milk or water. Get immediate medical attention. Never give anything by mouth to an unconscious person.

SECTION 5. FIRE FIGHTING MEASURES

Flash Point....................:	430.0 DEG F	221.11 DEG C
Method.........................:	PMCC	
Lower Explosive Limit.......:	N/A	
Upper Explosive Limit.......:	N/A	
Auto Ignition Temperature...:	N/A	
Extinguishing Media..........:	CO2,dry chemical,alcohol foam	

Firefighting Procedure:
Evacuate area and fight fire from safe distance. Wear self-contained breathing apparatus pressure-demand (MSHA/NIOSH-approved or equivalent) and full protective gear.

Special Firefighting Procedure:
Can burn in fire releasing toxic vapors. As in any fire wear self-contained breathing apparatus pressure-demand (MSHA/NIOSH approved or equivalent) and full protective gear. Using water can cause frothing with increasing fire intensity.

continued ...

SECTION 5. FIRE FIGHTING MEASURES ... continued

Unusual Fire and Explosion Hazards:
None.

Sensitivity To Explosion:
Explosion by mechanical impact - none.
Explosion by static discharge - none.

Conditions Of Flammability:
Avoid temperatures above flash point. May burn in a fire.

SECTION 6. ACCIDENTAL RELEASE MEASURES

General:
This material should be prevented from contaminating soil or from entering sewerage and drainage systems and bodies of water.
Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Prevent skin and eye contact. See Section 8 Exposure Controls/Personal Protection.

Small Spill:
Absorb spill with inert material (e.g., dry sand or earth), then place in a chemical waste container.

Large Spill:
Shut off leak, if safe to do so. Clean up spills immediately, observing precautions in Protective Equipment section. Contain spilled liquid with sand or earth. Retain all contaminated water for removal and treatment.

SECTION 7. HANDLING AND STORAGE

Handling:
Use with adequate ventilation. Avoid contact with skin and eyes. Wash thoroughly after handling.
Follow all MSDS/label precautions even after container is emptied because it may retain product residues.

Storage:
Keep container closed when not in use.

SECTION 8. EXPOSURE CONTROLS/ PERSONAL PROTECTION

continued ...

SECTION 8. EXPOSURE CONTROLS/ PERSONAL PROTECTION ... continued

Exposure Levels:

COMPONENT	OSHA TWA	OSHA STEL	OSHA CEL	ACGIH TWA	ACGIH STEL	ACGIH CEL	UNITS
None established	-	-	-	-	-	-	-

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to control sources of dust, mist or vapor.

Respiratory Protection:
A NIOSH/MSHA approved air purifying respirator may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits if established. Consult with respirator's manufacturer to determine the appropiate type of equipment for a given application. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection. A respiratory protection program that meets OSHA 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use.

Eye/Face Protection:
Use safety glasses. Where contact with the eyes is likely, use chemical goggles. Use a face shield as needed.

Skin Protection:
Wear impervious gloves and chemical protective clothing, including impervious sleevelets, overalls, aprons or boots as needed to prevent contact with skin.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Clear Yellow-Amber Liquid	
Odor	Mild	
Initial Boiling Point	N/A	N/A
Final Boiling Point	N/A	N/A
Specific Gravity (Relative to Water)	0.894	
Vapor Density(relative to air)	Heavier	
Vapor Pressure (mm Hg)	N/A	
pH	N/A	
Solubility in Water	Insoluble	
Freezing/Melting Point	-29F	
Octanol/water Partition Coefficient	N/A	

continued ...

N/A = Not Available

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES ... continued

Odor Threshold	:	N/A	
Flash Point	:	430.0 DEG F	221.1 DEG C
Auto-ignition Temperature	:	N/A	
Explosive Properties	:	None	
Oxidizing Properties	:	None	
Viscosity	:	315 cps	
Evaporation Rate (relative to n-Butylacetate)	:	Slower	

SECTION 10. STABILITY AND REACTIVITY

Stable:
Yes.

Strong Oxidizer:
No.

Hazardous Polymerization:
Not prone to hazardous polymerization.

Incompatibility:
Strong oxidizers and strong acids.

Conditions to Avoid:
Keep from contact with oxidizing materials.

Hazardous Decomposition Products:
Products of incomplete combustion may include CO, CO_2, and dense smoke.

SECTION 11. TOXICOLOGICAL INFORMATION

Toxicology:
Not available.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicological Information:
Not available.

Chemical Fate:
Not available.

SECTION 13. DISPOSAL CONSIDERATIONS

continued ...

SECTION 13. DISPOSAL CONSIDERATIONS ... continued

Waste Disposal:
Dispose of in accordance with all federal, state, and local regulations.

Container Disposal:
Dispose of in accordance with all federal, state, and local regulations.

SECTION 14. TRANSPORT INFORMATION

DOT Shipping Name...: Not Regulated
Hazard Class........:
Packing Group.......:
UN/NA No. ....:
DOT Labels..........:
Subsidiary Label....:
DOT Placards........:

IMO Shipping Name...: Not Regulated
Hazard Class........:
Packing Group.......:
UN No. ....:
IMO Labels..........:
Subsidiary Label....:

IATA Shipping Name..: Not Regulated
Hazard Class........:
Packing Group.......:
UN No. ....:
IATA Labels.........:
Subsidiary Label....:

SECTION 15. REGULATORY INFORMATION

SARA 311/312 Chronic Health Hazard : no
SARA 311/312 Acute Health Hazard.. : no
SARA 311/312 Fire Hazard.......... : no
SARA 311/312 Sudden Pressure...... : no
SARA 311/312 Reactivity Hazard.... : no

Section 302 Extremely Hazardous

Ingredients	CAS #	Weight %	TPQ
** None **			

CERCLA Hazardous Substances:

Ingredients	CAS #	Weight %	RQ
** None **			

Section 313 Toxic Chemicals:

Ingredients	CAS #	Weight %

continued ...

N/A = Not Available

POLYCIN® 934 M-4

SECTION 15. REGULATORY INFORMATION ... continued

** None **

NJ Environmental Hazardous Substance List:

Ingredients CAS #

** None **

California Proposition 65 Ingredients:

Ingredients CAS # Weight %

** None **

Reported in TSCA inventory:
Components - Listed in Inventory

SECTION 16. OTHER INFORMATION

HMIS Hazard Ratings:

Health............. : 1
Fire............... : 1
Reactivity......... : 0

NFPA Hazard Ratings:

Health............. : 1
Fire............... : 1
Reactivity......... : 0
Specific Hazard.... : None

Additional Regulatory Information:
N/A

NOTE:
This information is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of CasChem, Inc. The data on this sheet relates only to the specific material designated herein. CasChem, Inc. assumes no legal responsiblity for use or reliance upon these data.

N/A = Not Available

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CasChem, Inc.

A CAMBREX Company

VORITE® 715 M-1

16 Sections Printed:05/12/98

original: 10/20/90
revised: 05/12/98

MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

Manufacturer: CasChem, Inc.
40 Avenue A
Bayonne, NJ 07002

Information and Emergency Phone during business hours: 1-800CASCHEM

For use only in the event of chemical emergencies involving a spill, leak, fire, or accident with this material:
Call CHEMTREC 800 424-9300

Trade Name..........: VORITE® 715 M-1
Chemical Name.......: Mixture
Synonyms............:
....................:
....................:
CAS #...............: Mixture
Chemical Family.....: Urethane prepolymer
Product Code........: 72048
Product Use.........: Potting Compound/Encapsulant
PIN#................: None
WHMIS Class.........: D2A,D2B

SECTION 2. COMPOSITION/INFORMATION ON COMPONENTS

COMPONENTS	CAS #	WEIGHT %
Dioctyl Adipate	103-23-1	57%
4,4'-Methylene diphenyl diisocyanate (MDI)	101-68-8	7-13%
Polymethylene Polyphenylisocyanate	9016-87-9	5-10%
** Trade Secret **		

SECTION 3. HAZARDS IDENTIFICATION

Emergency Overview:
Brown liquid with aromatic odor. Can evolve irritating and/or sensitizing vapors when heated or burning. Skin and eye irritant. Sensitizer. Hot liquid can react vigorously with water, generating CO_2.

Breathing:
MDI vapors or mists at excessive levels can irritate the mucous membranes causing runny nose, sore throat, coughing, chest discomfort, fever, shortness of breath, and reduced lung function. Persons with preexisting, nonspecific brochial hyperactivity can respond to lower concentrations with similar symptoms as well as asthma attack. Overexposure may lead to bronchitis, bronchial spasm and fluid in the lungs. These symptoms are usually reversible. Chemical and hypersensitive pneumonitis, with flu-like symptoms have been reported. These symptoms can be delayed up to several hours after exposure.

continued ...

N/A = Not Available

SECTION 3. HAZARDS IDENTIFICATION ... continued

Skin Contact:

May cause allergic reaction, e.g., reddening, swelling, rash, scaling, or blistering.

Eye Contact:

May cause severe irritation, including tearing, reddening, and swelling. If untreated, corneal damage may occur and injury is slow to heal. However, damage is usually reversible.

Swallowing:

May cause abdominal cramps, nausea, and diarrhea.

Condition Aggravated by Exposure:

Asthma, other respiratory disorders such as bronchitis, emphysema, bronchial hyperactivity, skin allergies, eczema.

Long Term Effects:

Dioctyl adipate has produced liver effects, including liver tumors, in animal feeding studies. However, IARC has classified dioctyl adipate as a Group 3 material - not classifiable as to human carcinogenicity. Individuals sensitized from prior contact to diisocyanates may react to low levels of MDI. Symptoms can include chest tightness, wheezing, coughing, shortness of breath or asthma attack, and may be immediate or delayed for several hours. Onset may occur from exposure to dust, cold air, or other irritants. Increased sensitivity can persist for weeks to years. Overexposure may cause lung damage, including decreased lung function.

SECTION 4. FIRST AID MEASURES

Breathing:

Rescuers should put on appropriate protective gear. Remove from area of exposure. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Keep victim warm. Get immediate medical attention.

Skin:

Wash with soap and water. Immediately flush with large amounts of water for at least 15 minutes. Use soap if available. Remove contaminated clothing, including shoes, after flushing has begun. Get prompt medical attention if symptoms occur. Thoroughly wash or discard clothes and shoes before reuse.

continued ...

SECTION 4. FIRST AID MEASURES ... continued

Eye:
Immediately flush eyes with plenty of water for at least 15 minutes, holding eyelids apart. Get medical attention if irritation or other symptoms occur.

Swallowing:
Get immediate medical attention. Never give anything by mouth to an unconscious person.

SECTION 5. FIRE FIGHTING MEASURES

Flash Point.................:	400 deg F	204 deg C
Method......................:	pmcc	
Lower Explosive Limit.......:	N/A	
Upper Explosive Limit.......:	N/A	
Auto Ignition Temperature...:	N/A	
Extinguishing Media.........:	CO2,dry chemical,alcohol foam	

Firefighting Procedure:
Evacuate area and fight fire from safe distance. Wear self-contained breathing apparatus pressure-demand (MSHA/NIOSH-approved or equivalent) and full protective gear.

Special Firefighting Procedure:
Can burn in fire releasing toxic vapors. As in any fire wear self-contained breathing apparatus pressure-demand (MSHA/NIOSH approved or equivalent) and full protective gear. Using water can cause frothing with increased fire intensity.

Sensitivity To Explosion:
None expected by mechanical impact or static discharge

Conditions Of Flammability:
Material may burn, but does not ignite readily. Avoid high temperatures.

SECTION 6. ACCIDENTAL RELEASE MEASURES

General:
Minimize entry of material into sewers and drainage systems. Refer to permit discharge limitations if applicable. Isolate spill area, preventing entry by unauthorized persons. Prevent skin/eye contact.

continued ...

SECTION 6. ACCIDENTAL RELEASE MEASURES ... continued

Spill Clean-up Procedure:

Stop leak if safe to do so. Contain spill and absorb with inert material (e.g., dry sand or earth). Place in an approved chemical waste container. Observe precautions in this material safety data sheet.

SECTION 7. HANDLING AND STORAGE

Handling:

Use with adequate ventilation. As with all chemical products, follow good hygiene practices. These include avoiding contact, using personal protective equipment as needed to prevent contact, and washing after handling. Follow same precautions when handling emptied container since it may retain product residues.

Storage:

Store in cool, dry location. Keep container closed when not in use.

SECTION 8. EXPOSURE CONTROLS/ PERSONAL PROTECTION

Exposure Levels:

	OSHA			ACGIH			UNITS
COMPONENT	TWA	STEL	CEL	TWA	STEL	CEL	
4,4'- Methylene diphenyl diisocyanate	-	-	0.02	0.005	-	-	ppm

Engineering Controls:

Use process enclosures, local exhaust ventilation, or other engineering controls to control sources of dust, mist or vapor.

Respiratory Protection:

Use NIOSH/MSHA approved respirator when airborne exposure may exceed exposure limits. Due to the poor warning properties of isocyanates, a positive pressure supplied-air respirator must be worn when exposures exceed exposure limits, when exposure limits are unknown, or when there is any potential for uncontrolled release of isocyanate vapors. Consult with respirator's manufacturer to determine the appropriate type of equipment for a given application. A respiratory protection program that meets OSHA 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant respirator use.

Eye/Face Protection:

Wear splash-proof chemical goggles and a faceshield.

continued ...

SECTION 8. EXPOSURE CONTROLS/ PERSONAL PROTECTION ... continued

Skin Protection:
Wear chemical resistant gloves. Cover all exposed skin with clean, protective clothing as appropriate.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Brown liquid	
Odor	:	Odorless	
Initial Boiling Point	:	N/A	N/A
Final Boiling Point	:	N/A	N/A
Specific Gravity (Relative to Water)	:	1.01 @ 25C	
Vapor Density(relative to air)	:	Heavier	
Vapor Pressure (mm Hg)	:	N/A	
pH	:	N/A	
Solubility in Water	:	Nil	
Freezing/Melting Point	:	N/A	
Octanol/water Partition Coefficient	:	N/A	
Odor Threshold	:	N/A	
Viscosity	:	135 cps @ 25C	
Evaporation Rate (relative to n-Butylacetate)	:	Slower	

SECTION 10. STABILITY AND REACTIVITY

Stable:
Yes.

Strong Oxidizer:
No.

Hazardous Polymerization:
Not prone to hazardous polymerization.

Incompatibility:
Can react vigorously with oxidizing materials. Avoid contact with water, amines, and alcohols.

Conditions to Avoid:
Keep from contact with incompatible materials. Avoid temperatures over 400 degrees F. May cause some corrosion to copper alloys and aluminum.

Hazardous Decomposition Products:
Isocyanate vapor and mist, carbon dioxide, carbon monoxide, nitrogen oxides, and traces of hydrogen cyanide.

N/A - Not Available

SECTION 11. TOXICOLOGICAL INFORMATION

Toxicology:
Vorite 715 M-1 (product code 72048);
Oral LD50, rat; >500 mg/kg
Dermal LD50, rabbit; >1000 mg/kg
Inhalation LC50, rat; >10 mg/L (aerosols)

Toxicology:
4,4'-Methylene diphenyl diisocyanate (CAS# 101-68-8);
Eye irritation, rabbit; 100 ug - mild
Oral LD50, rat; 31960 mg/kg
Inhalation LC50, rat; 369-380 mg/m3/4hr
Mutagenic in TA98 and TA100 S. typhimurium test with activation

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicological Information:
Not available.

Chemical Fate:
Not available.

SECTION 13. DISPOSAL CONSIDERATIONS

Waste Disposal:
Dispose of in accordance with all federal, state, and local regulations.

Container Disposal:
Dispose of in accordance with all federal, state, and local regulations.

SECTION 14. TRANSPORT INFORMATION

DOT Shipping Name...: Not Regulated
Hazard Class........:
Packing Group.......:
UN/NA No. ....:
DOT Labels..........:
Subsidiary Label....:
DOT Placards........:

IMO Shipping Name...: Not Regulated
Hazard Class........:
Packing Group.......:
UN No. ....:
IMO Labels..........:
Subsidiary Label....:

IATA Shipping Name..: Not Regulated

continued ...

N/A = Not Available

SECTION 14. TRANSPORT INFORMATION ... continued

Hazard Class........:
Packing Group.......:
UN No. ....:
IATA Labels.........:
Subsidiary Label....:

SECTION 15. REGULATORY INFORMATION

SARA 311/312 Chronic Health Hazard : yes
SARA 311/312 Acute Health Hazard.. : yes
SARA 311/312 Fire Hazard.......... : no
SARA 311/312 Sudden Pressure...... : no
SARA 311/312 Reactivity Hazard.... : no

Section 302 Extremely Hazardous:

Ingredients	CAS #	Weight %	TPQ
** None **			

CERCLA Hazardous Substances:

Ingredients	CAS #	Weight %	RQ
4,4'-Methylene diphenyl diisocyanate (MDI)	101-68-8	7-13%	5000

Section 313 Toxic Chemicals:

Ingredients	CAS #	Weight %
4,4'-Methylene diphenyl diisocyanate (MDI)	101-68-8	7-13%
Polymethylene Polyphenylisocyanate	9016-87-9	5-10%

NJ Environmental Hazardous Substance List:

Ingredients	CAS #
** None **	

California Proposition 65 Ingredients:

Ingredients	CAS #	Weight %
** None **		

TSCA:
Components of this product are listed on the TSCA inventory.

DSL/EINECS:
The components of this product are listed on the Canadian Domestic Substances List and the European Inventory of Existing Commercial Chemical Substances.

WHMIS:
This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required in the CPR. This product meets CPR classification criteria D2A and D2B. Note - the trade secret component does not meet the hazard criteria of the Controlled Product Regulations and is not listed on the Ingredient Disclosure List.

SECTION 16. OTHER INFORMATION

NFPA Hazard Ratings:
Health............. : 2
Fire............... : 1
Reactivity......... : 1
Specific Hazard.... : None

HMIS Hazard Rating:
Health............. : 2
Fire............... : 1
Reactivity......... : 1

MSDS Revisions:

2/3/95; Modified SARA 313 information and added WHMIS, DSL, and EINECS information (sect 15)
8/10/95; Added component information (sect 3)
10/20/95; Modified WHMIS statement to conform to Policy Issue Sheet recommendations on ILO 16-heading format (sect 15)
5/12/98; Re-assessed product hazards (no substantive changes)

NOTE:

This information is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of CasChem, Inc. The data on this sheet relates only to the specific material designated herein. CasChem, Inc. assumes no legal responsiblity for use or reliance upon these data.

N/A = Not Available

SOLAR COMPOUND CORPORATION

1201 WEST BLANCKE STREET P.O. BOX 1097 LINDEN, N.J. 908-862-28

SECTION A PRODUCT INDENTIFICATION

PRODUCT NAME: MIX-96 DATE ISSUED: 3/12/96

FOR CHEMICAL EMERGENCY CALL CHEMTREC 1-800-424-9300.:

SECTION B COMPONENTS AND HAZARD INFORMATION

THE FOLLOWING CHEMICALS ARE SUBJECT TO THE REPORTING REQUIREMENTS OF SECTI 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986 AND 40 CFR 372.

COMPONENT	CAS #	CONCENTRATION	SECTION 3
1: ASPHALT	8052-42-4	70% to 90%	NO
2:			
3:			
4:			
5:			

ARMORING TAR

SECTION C PRIMARY ROUTE OF ENTRY AND EMERGENCY FIRST AID PROCEDURES

EYE CONTACT: Fumes may cause mild irritation. Flush with clear water for minutes or until irritation subsides. If irritation persists, call a physician.

SKIN CONTACT: If molten, cool with water immediately. DO NOT try to peel solidified material from the skin or use solvents to dissolve it. The use vegetable oil or mineral oil is recommended for removal of this material f the skin. Follow standard first aid procedures for burns. Call a physici

INHALATION: AVOID FUMES. If overcome by vapor, remove from exposure and a physician immediately. If breathing is irregular or has stopped, start resuscitation, administer oxygen, if available.

INGESTION: DO NOT induce vomiting. In general, no treatment is necessary unless large quantities are ingested; however, get medical advice.

SECTION D FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT: 378° F METHOD USED: COC

AUTO-IGNITION TEMPERATURE: NA

EXPOSURE LIMIT: NA
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)
BASIS- As interpreted by Solar Compounds

HEALTH	FLAMMABILITY	REACTIVITY	PERSONAL PROTECT
1	1	0	H

HANDLING PRECAUTIONS: Keep containers closed when not in use. Do not st near heat, sparks, flames, or strong oxidants. Do not allow water to mix hot asphalt. Steam generated eruptions may occur.

FLAMMABLE OR EXPLOSIVE LIMITS (APPROXIMATE PERCENT BY VOLUME IN AIR):

LEL Lower NA
UEL Upper NA

EXTINGUISHING MEDIA AND FIRE FIGHTING PROCEDURES: Water may be ineffective because of frothing. Foam, dry chemical, CO_2, or FOG should be used.

SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus for enclosed areas.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hot asphalt may ignite flammable materi on contact. Keep away from strong oxidants.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS: Carbon monoxide and carbon dioxide gasses.

"EMPTY" CONTAINER WARNING: "EMPTY" containers retain residue (liquid and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition: they may explode and cause injury or death. Do not attempt to clean since residue is difficult to remove. "Empty" drums shoul be completely drained, properly bunged and promptly returned to a drum reconditioner. All other containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations

SECTION E HEALTH HAZARD INFORMATION

HEALTH HAZARD ACUTE: NA

HEALTH HAZARD CHRONIC: Mild eye irritation from vapors.

IS MATERIAL CARCINOGENIC?: No

EMERGENCY FIRST AID PROCEDURES: If molten, cool with water immediately. DO NOT try to peel the solidified material from the skin or use solvents to disolve it. The use of vegetable oil or mineral oil is recommended for removal of this material from the skin. Follow standard first aid procedur for burns. Call a physician.

SIGNS AND SYMPTOMS OF EXPOSURE: Mild irritation of exposed area.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: NA

SECTION F PHYSICAL DATA:

The following data are approximate or typical values and should not be used for precise design purposes.

BOILING POINT: 800-780° F

VAPOR PRESSURE: NA

SPECIFIC GRAVITY (Water = 1): NA

VAPOR DENSITY (Air =1): NA

SOLUBILITY IN WATER: NIL

REACTIVITY IN WATER: NONE

MELTING POINT: NA

VISCOSITY @ 25 C: NA

APPEARANCE AND ODOR: Black semi-solid with a distinctive odor.

SECTION G REACTIVITY:

This product is stable and will not react violently with water. Hazardous polymerization will not occur. Avoid contact with strong oxidant such as liquid chlorine, concentrated oxygen, sodium hypochlorite or calciu hypochlorite.

SECTION H SPILL OR LEAK PROCEDURES:

THE FOLLOWING STEPS SHOULD BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Shut off and eliminate all ignition sources. Keep people away. Allow product to cool. Recover free product. Add sand, earth, or other suitable absorbent to spill area. Minimize breathing vapors. Minimize skin contact Ventilate confined spaces. Open all windows and doors. Keep product out o sewers and watercourses by diking or impounding. Advise authorities if product has entered or may enter sewers, watercourses, or extensive land areas.

Assure conformity with applicable government regulations in disposing of waste.

SECTION I PROTECTION AND PRECAUTIONS

VENTILATION: Mandatory for confined operations.

RESPIRATORY PROTECTION: Use organic vapor canister unit (U.S. Bureau of Mi or equivalent.

PROTECTIVE GLOVES: Use gloves when handling hot compound and there could b direct contact. Long sleeve shirt and long pants are also recommened.

EYE PROTECTION: Use splash goggles or face shield when eye contact may occ

OTHER PROTECTIVE EQUIPMENT: Use chemical resistant apron or other impervio clothing, if needed, to avoid contaminating regular clothing which could result in prolonged or repeated skin contact.

WORK PRACTICES/ENGINEERING CONTROLS: Keep containers closed when not in us Do not store near heat, sparks, flame or strong oxidants. In outdoor applications where material is heated, keep kettle downwind of workers.

PERSONAL HYGIENE: Minimize breathing vapor or mist. Avoid prolonged or repeated contact with skin. Remove contaminated clothing, launder or dry clean before reuse. Cleanse skin thoroughly after contact, before breaks meals, and at end of work period. Skin cream should be applied prior to u of this product.

SECTION J TRANSPORTATION INFORMATION

TRANSPORTATION INCIDENT INFORMATION: For further information relative to spills resulting from transportation incidents, refer to latest Departmen Transportation Emergency Response Guidebook for Hazardous Materials Incid DOT P 5800.3.

DOT IDENTIFICATION NUMBER: NOT REGULATED BY DOT

The information and recommendations contained herein are, to the best o Solar Compounds knowledge and belief, accurate and reliable as of the date issued. Solar Compounds does not warrant or guarantee their accuracy or reliability, and Solar Compounds shall not be liable for any loss or damage arising out of the use thereof.

The information and recommendations are offered for the user's consideration and examination, and it is the user's responsibility to satisf itself that they are suitable and complete for its particular use.

The Hazardous Materials Identification System (HIMS) and National Fire Protection Association (NFPA) ratings have been included by Solar Compounds order to provide additional health and hazard classification information. T ratings recommended are based upon the criteria supplied by the developers o these ratings systems, together with Solar Compounds interpretation of the available data.:

EXCEPTIONAL RHEOLOGY™

5X346A

Material Safety Data Sheet POLAR MINERALS

Effective 1-15-95

TRADE NAME: 8100 Series, 8100 Coated Series, Polishing Marl. Magnum Gloss 81.4,81.4C
CHEMICAL NAME: Limestone, Whiting, Calcium Carbonate

[illegible]

MANUFACTURERS NAME: Polar Minerals, Inc.
1703 Bluff Road
Mt. Vernon, IN 47620
812-838-5236 FAX: 812-838-4744

[illegible]

MATERIAL: Calcium Carbonate **CAS NO:** 471-34-1

[illegible] HEALTH HAZARD [illegible]

ROUTES OF HAZARD	BASIS FOR DETERMINATION
Inhalation	OSHA PEL: 15.0 mg/cu. meter (total dust) OSHA PEL: 5.0 mg/cu. meter (respirable dust) ACGIH TLV: 10 mg/cu. meter (respirable dust)

EFFECTS OF ACUTE OVEREXPOSURE: No Acute Effects.

EFFECTS OF CHRONIC OVEREXPOSURE: As is true with any mineral product, long term overexposure to high concentrations of this dust without the use of a dust mask may produce X-Ray evidence of respiratory dysfunction in some individuals.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Unknown

EYES AND SKIN: No special precautions, flush with water 15 minutes.

INHALATION AND INGESTION: No special precautions

[illegible] IV. PHYSICAL DAT[illegible]

BOILING POINT:	N/A	**SPECIFIC GRAVITY:**	2.71
VAPOR PRESSURE:	N/A	**MELTING POINT:**	Decomposes at 1799 F.
VAPOR DENSITY:	N/A	**EVAPORATION RATE:**	N/A
SOLUBILITY IN WATER:	Negligible		
APPEARANCE AND ODOR:	White Odorless powder		
pH:	8.5-9.5 at 10% solids		

V. FIRE AND EXPLOSION [illegible]

FLASH POINT: None
FLAMMABLE LIMITS IN AIR: N/A
AUTOIGNITION TEMP: None

SPECIAL FIRE FIGHTING PROCEDURES: None
UNUSUAL FIRE AND EXPLOSION HAZARD: None

VI. REACTIVITY [illegible]

CONDITIONS CONTRIBUTING TO INSTABILITY: Reacts with Acids to liberate CO_2.
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION: None
HAZARDOUS DECOMPOSITION PRODUCTS: None

VII. DISPOSAL, SPILL [illegible]

WASTE DISPOSAL METHOD:

Calcium Carbonate is not classified as a hazardous waste under RCRA Section 3001. Use normal solid waste disposal procedures which are in compliance with Federal, State, and Local Regulations.

SPILL OR LEAK PROCEDURES:
Calcium Carbonate is not classified as a toxic pollutant or a hazardous substance under Sections 307 and 311 of the Clean Water Act. Accidental releases can be cleaned up by sweeping, vacuuming, or flushing with water.

NEUTRALIZING CHEMICALS: None Required

VIII. SPECIAL PROTECTION INFORMATION

VENTILATION:
Use sufficient general area ventilation. Local exhaust may be necessary where Threshold Limit Values (TLV's) are exceeded or dusty conditions exist.

PERSONAL PROTECTIVE EQUIPMENT:

EYE: Non-essential but desirable.
GLOVES: Non-essential.
OTHER: None.
RESPIRATORY PROTECTION: For dusty conditions use a dust mask approved by NIOSH.

OTHER:
Calcium Carbonate accumulations on walking surfaces will cause very slippery conditions.
This product is labeled in accordance with OSHA's Hazard Communication Regulations (29 CFR 1910.1200) and the HMIS Rating System. Contact:

HEALTH	1
FLAMMABILITY	0
REACTIVITY	0
PERSONAL PROTECTION	E

The National Paint and Coatings Association
1500 Rhode Island Ave., N.W.
Washington, D.C. 20005

ADDITIONAL REGULATORY CONCERNS:
USDA: None CPSC: None SARA 313: None OTHER: None TSCA: Listed KOREA: Listed
DSL: Listed EINECS: Listed AUSTRALIAN: Listed

Appendix C

Technical Description of the Seaplow

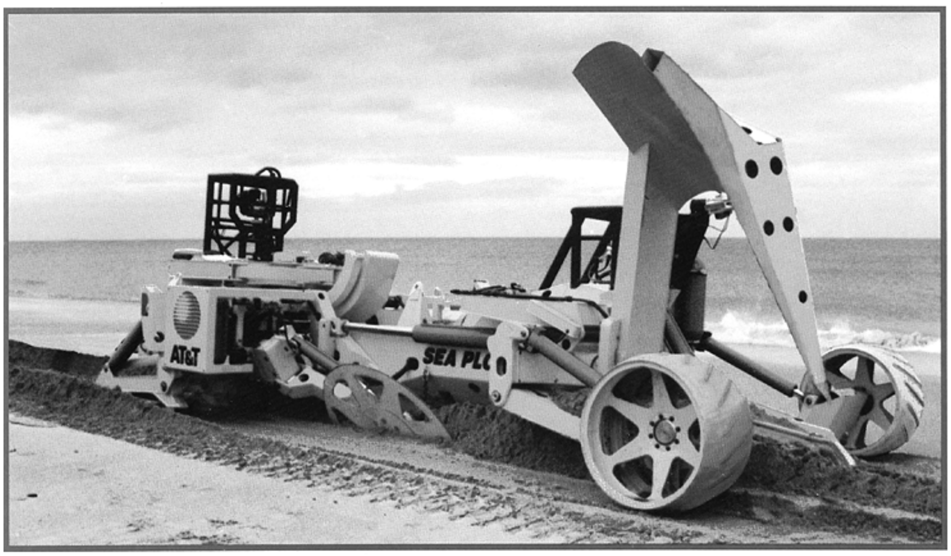
(Earth Tech 1999)

C.1 GENERAL DESCRIPTION

The Sea Plow VII (SPVII) is a state-of-the-art submarine cable installation burial tool. It is capable of burial to depths of one meter in most seabed soils. The system can operate in depths up to 1,400 meters and is able to bury up to 140mm diameter cables and flow lines, as well as repeaters up to 400mm in diameter.

The SPVII features efficient diverless operation and vehicle control, as well as landing stabilizers incorporating a speed, distance and depth measuring wheel. It also has a single thruster to maintain plow alignment during deployment. Its portability, low maintenance, and superior capabilities make SPVII an effective solution for a wide range of undersea tasks and environments. The SPVII is shown in Figure C-1.

Figure C-1. The Sea Plow VII



C.2 OPERATIONAL HISTORY

Since its first operation, the SPVII has completed an impressive record of over 1,000 km of cable installation and burial. A sample of these projects is listed in Table C-1.

Table C-1. Sea Plow VII Operational History

Year	Project	Length of Burial
1992	TCP-4 Canadian Shelf	68 km
1993	APC Sea-Me-We	246 km 210 km
1994	TCP-5 California Shelf	134 Km
1996	TCP-5 Oregon Shelf	61 Km
1998	AC-1	1625 Km
1998	Alaska-United	737 Km

C.3 PLOW CHARACTERISTICS

Following is a description of the SPVII plow characteristics.

Plowing Action

The plow moves the soil in such a way that it leaves the cable buried beneath a level seabed under soil that retains most of its undisturbed strength. The plow achieves this by cutting a wedge of soil using an inclined freely rotating disc cutter, a sharp knife, and a horizontal point. The wedge of soil is then lifted upwards by an inclined ramp. As the wedge is lifted up, it is also pushed outward and rises up the sloping surface cut by the disc. The cable is then inserted into the ground and the wedge of soil is replaced over the cable. In clay soils the plow handles the soil so gently that the soil retains its strength, leaving a level surface with only two knife cuts to show the plow has passed by.

Cable Flow through Plow

The bellmouth lifts the cable off the ground in front of the plow. The cable passes between two vertical tubes that sense the cable arrival angle. Behind the bellmouth the cable passes over the slack accumulator and then into the plow share. The cable goes through an S-bend formed by the plow share and the depressor. The depressor can be lifted for cable loading, and has an adjustable down position to accommodate different cable diameters. The force required to hold the depressor down is measured and calibrated to provide a reading of cable tension as it leaves the plow.

The structure of the plow is to the side of the cable route, and is arranged to leave one side of the cable route open for easy loading and unloading. The cable does not require a free end to be loaded into the plow. The bellmouth at the front of the plow accepts cable entry angles of 90 degrees upwards, 25 degrees downwards and plus or minus 30 degrees horizontally. The upper part of the bellmouth houses the front camera, two lights, the obstacle avoidance SONAR and the cable entry angle feelers.

Repeater Burial

Repeaters and large joints are buried by temporarily increasing the width of the trench cut by the plow. This is achieved by deploying a secondary share on the port side of the primary plow share. The secondary share removes the wedge of soil defined by the disc and the primary share and places the soil alongside the trench. In conditions where the plow is working at full burial depth (1.1m), the depth of cover over a standard repeater (up to 400mm diameter) is approximately 700mm.

Depth Control

The depth of plowing is controlled by raising or lowering the skids relative to the plow chassis. Deeper burial is achieved by raising the skids and shallower burial is achieved by lowering the skids. The nominal set depth of the plow is measured by two continuously linear variable displacement transducers, one on each side of the skid arm mechanisms. The actual plowing depth is measured by the LVDTs fitted to the stabilizer arms.

Steering

The plow is steered to either side of the towing ship by moving the hitch point laterally across the plow. Enough movement is provided so that the plow runs with the tow rope making an angle of up to 15 degrees to either side of the track of the ship. The maximum angle achieved depends on the tow force and soil type. A maximum of 12 degrees is achievable. The primary information used to steer the plow when tracking along the cable comes from the cable feelers which measure the angle in the horizontal plane at which the cable enters the plow bellmouth.

Stabilizers

Two stabilizers are fitted to the rear of the plow to limit sinkage in very soft soil conditions. The stabilizers also increase the stability of the plow during deployment and recovery. The two stabilizers are individually moved by hydraulic cylinders and can be set to float in order to follow ground contours. The outboard end of each stabilizer is a wheel which normally runs on the ground. Each wheel houses a rotation sensor which provides measurement of plow speed and distance traveled. The range of movement of the stabilizer arms is sufficient enough that when fully raised, the plow is able to cut to the full specified burial depth.

Plow Flying

The ability to fly the plow over seabed obstacles and re-deploy without recovery to the surface is facilitated by the moving drawbar assembly. A 1.5m minimum bending radius is maintained in the buried cable during this operation. The single thruster mounted directly over the front hydraulics package are used to maintain the plow heading during flying operations.

Disc Cutter

The plow is fitted with a disc cutter to reduce towing forces and improve burial quality. The disc cuts one side of a soil wedge at an angle of 35 degrees to the vertical. The other side of the wedge is cut by the vertical knife on the leading edge of the plow share. The disc position is controlled by a hydraulic cylinder. It rides over rocks or obstacles on the seabed by retracting against a relief valve. An operator in the control cabin can alter the vertical position of the disc. The disc position is monitored by a displacement transducer. The actual position chosen depends on the plowing depth.

C.4 INSTRUMENTATION

Following is a description of the SPVII instrumentation.

Force Measurement

All force measurements are made using strain gauged shear pin load cells made of high tensile stainless steel and specifically designed for each application. Each load cell has an underwater mateable connector and contains a line amplifier to give out a 4 to 20mA signal with a 12V DC input.

Shear pin load cells are used to monitor the following functions:

- Tow force (measured at both port and starboard bridle leg terminations)
- Umbilical tension
- Residual cable tension (tension of the lay cable as it leaves the plow)
- Slack accumulator cable tension (tension of the lay cable as it passes over the slack accumulator)
- Port and starboard skid force (load in the port and starboard skid hydraulic cylinder)

Monitoring the port and starboard skid force gives the operator an indication of when the front of the plow becomes light because of too much vertical towing force. This indicates the tow rope is too short.

Distance Measurement

A rotary encoder mounted in the hub of each stabilizer ground wheel measures plow speed and distance traveled.

Inclinometer

Two inclinometers contained in the electronics pod measure the pitch and roll of the plow relative to the horizontal plane.

Compass

The compass is mounted on the starboard side of the rear hydraulics frame. The frame tubes immediately surrounding the compass are stainless steel. The unit itself is an oil filled stainless steel pressure vessel with a GISMA bulkhead connector on the end plate. It is a four-wire device supplied with 24V DC from the pod and with an output of 0 to 10V DC corresponding to 0 degree to 359 degree heading.

Echo Sounder

To measure plow altitude, a single echo sounder is fitted on the forward side of the starboard rear beam. The range of the unit is 0 to 100m and is of most use during the landing stage of deployment. An output of 0 to 10V corresponds to the 0 to 100m range. This device may also provide some indication of plow burial depth during plowing operations.

Cable Counter

The length of the cable passing through the plow is measured by a cable wheel which lies in the rear section of the slack accumulator and is sprung downwards against the cable. The hub of the cable wheel is fitted with an encoder identical to that used on the ground wheel. The cable wheel is coated with techtane polyurethane (60 shores hardness).

C.5 SURVEILLANCE EQUIPMENT

Following is a description of the SPVII surveillance equipment.

Cameras/Lights

The plow is fitted with 3 Silicone Intensified Target (SIT) black and white wide angle cameras, two of which are mounted on electric pan and tilt units. The forward camera is on a pan and tilt unit and is positioned in a tubular cage which forms part of the plow bellmouth. This camera is primarily used to view the cable as it enters the bellmouth, but with good visibility can also be used to monitor the tow bridle and front skids. One of the five thallium iodide LT-7 lights is mounted alongside this camera on the pan and tilt unit. A second light is also mounted in the bellmouth in a fixed position to illuminate an area immediately ahead of the plow.

The rear camera is also mounted on a pan and tilt unit together with the third light. This camera is situated on the rear bridge where it monitors the cable leaving the slack accumulator and going into the plow share. The third camera and the fourth light are mounted facing the rear of the plow on the rear bellmouth to give a view of the cable route in the center of the plow. The fifth light is located on the front of the rear bridge to provide general background illumination.

Obstacle Avoidance SONAR

Simrad Mesotech M-971 An obstacle avoidance SONAR is mounted high up inside the plow bellmouth at the front of the plow. This SONAR is used to continually scan the terrain up to 200m ahead of the plow for any obstacles which may be hazardous to the plowing operations.

Hydrophone

A sensitive hydrophone is mounted on the plow. The hydrophone is used to give the operator an audio account of the plowing operation. Its output is useful for determining the soil conditions in which the plow is working and for listening to the operation of the hydraulic motors and valves.

Vehicle Tracking System

The plow is fitted with a SIMRAD vehicle tracking system. This system provides the operator in the control cabin with data on the location of the plow relative to the lay ship and cable route.

C.6 SURFACE SUPPORT EQUIPMENT

Following is a description of the SPVII surface support equipment.

Umbilical Winch

The umbilical winch is a single drum driven by a hydraulic motor via reduction gearing. The power source is a separate electro-hydraulic power pack which also supplies the A-frame. The winch is designed to be compact and fit within a standard ISO container for transport. It has a rugged frame structure suitable for shipboard mounting and is fitted with lifting eyes.

In the event of an umbilical failure, a spare umbilical is provided on a spare drum which can readily be interchanged with the drum on the winch. The interchange is possible at sea, but requires a suitable crane of at least 20 tonnes Safe Working Load (SWL). A level wind mechanism responds to drum rotation and changes cable fleet angle to ensure proper reeling of the cable on the drum.

The winch includes a slip ring assembly, local and remote control systems, and a mechanical brake which is held off hydraulically. The brake acts on the drum only in the event of a power failure. The brake is set to hold 4.5 tonnes and is not adjustable.

Umbilical Cable

The double-armored umbilical, measuring 4,000m in length, encases fiber optic links for all data multiplexed between the plow and the control cabin. The umbilical has a breaking strength of 230kN and weighs approximately 2.5kg/m in the air.

Traction Winch

The traction winch (65 tonnes SWL) consists of two grooved drums mounted on parallel horizontal axes. Both drums are driven, via a gear reduction, by a slow speed, high torque radial piston hydraulic motor. A fail safe disc brake is fitted between the motor and drive piston. A compensator is mounted above the traction winch and ensures tension in the rope between the traction winch and the storage winch.

Tow Wire

The tow wire consists of a high carbon steel wire, multi-stranded, non-rotating rope. The tow wire is 46mm in diameter and is 3,600m in length. It is used to launch and recover the plow and to tow the plow across the seabed during operations. The working loads vary from 0 to 60,000 pounds (27.2 tonnes) with occasional peak loads of 120,000 pounds (54 tonnes). The minimum breaking strength of the tow wire is 385,000 pounds.

Launch and Recovery System

The plow is launched and recovered on a dedicated A-frame handling system fitted with a simple scissor-frame assembly. The A-frame is designed so that it has a large range of movement to permit the plow to be picked up from close to the sea surface and placed on the deck of the support vessel well inboard using the same rope for towing and handling without the need for removing the rope from the A-frame sheave or roller.

The capacity of the A-frame is 35 tonne SWL, with an 11m reach. As the plow is raised, the tow rope/ bridle connection passes through the docking frame guide. Continued raising causes the bridle to become steadily more restrained by the scissors frame. As the plow lifts against the frame, the plow becomes restrained from sideways movement.

C.7 ADDITIONAL DATA

Table C-2 lists the SPVII general specifications and Table C-3 lists the SPVII weights and dimensions.

Table C-2. Sea Plow VII General Specifications

Item	Description
General	
Maximum Operating Depth	1,400 meters
Trench Depth	0 - 1.1 meters
Cable Size	Up to 150mm diameter
Repeater Size	Up to 400mm diameter
Tow Method	Surface vessel (10-50 metric tons tow force)
Soil Types	5 kPa mud to soft rock
Major System Components	
Main Control Equipment	Sea Plow VII Vehicle
	1 x Control Van
	1 x Maintenance Van
	1 x Spare Van
Launch & Recovery System	A-frame (35 tons SWL)
	Tow Winch (65 tones SWL) with take up reel
	Tow Wire
	Stern Roller Assembly
Umbilicals	1 x 4,000 meters
	1 spare x 4,000 meters
Hydraulic System	15 kW electro-hydraulic power pack (35 functions)
Vehicle Accessories	
Instrumentation	2 inclinometer
	21 transducers
	10 contact closures
	5 moisture detectors
	3 echo sounders
	1 heading sensor compass
`	2 temperature sensors
	Obstacle avoidance sonar
	hydrophone
Surveillance	Obstacle avoidance sonar hydrophone
	3 B&W SIT cameras with Pan and Tilt units
	4 lighting units
Emergency Systems	Sonar triggered cable release 2 emergency lift ropes

Table C-3. Sea Plow VII Weights and Dimensions

Item	Weight (tonnes)	Dimensions (L x W x H meters)
Plow	14.0	10.5 x 6.0 x 4.3
Control Cabin	5.0	6.1 x 2.5 x 2.5
Maintenance Van	5.0	6.1 x 2.5 x 2.5
Umbilical Winch	22.0	3.7 x 2.4 x 4.3
Umbilical/A-Frame (HPU)	10.1	6.2 x 2.5 x 2.5
Spare Umbilical (drum)	14.0	2.4 x 2.4 x 2.4
Float Box 1	3.0	3.0 x 2.5 x 2.6
Float Box 2	3.0	3.0 x 2.5 x 2.6
65T Traction Winch	24.0	5.2 x 2.3 x 4.2
Tow Wire Storage Reel	45.2	3.4 x 3.4 x 3.4
A-Frame Assembly	40.0	12.0 x 10.5 x 3.5
Traction Winch Power Unit	7.5	4.5 x 2.5 x 1.9
Stern Roller	8.7	2.3 x 2.5 x 2.4
Docking Head	5.0	2.0 x 4.5 x 2.3
Misc. Storage Boxes (8)	4.0	1.0 x 1.0 x 1.0

Appendix D

Threats to Submarine Cables

Threats to Submarine Cables

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1. ABSTRACT

While submarine cable systems are a highly reliable means for information transmission, faults due to external aggression are a major source of concern for both suppliers and system owners. This paper will first discuss historical trends in system fault experience, and then detail the nature of the threats from shipping and fishing activities. Finally, recommendations will be given for minimizing system vulnerability to such threats.

2. NATURAL AND HUMAN SOURCES OF CABLE FAULTS

Threats to submarine cable vary significantly for all cable landings dependent upon their geographical location. They result from a multiplicity of factors such as the presence of fishing grounds, the proximity of cable landing sites to busy harbours, waterways and associated anchorages and the length of the continental shelf and the system's routing to deep water.

Natural occurrences such as earthquakes and landslides have damaged cables, but the vast majority of cable faults are caused by human activity in the ocean. Data for the Atlantic Ocean and the Caribbean Sea from 1959 to 1996, presented in Figure 1, shows that less than 9% of all faults are caused by natural events. The peak in natural faults in 1986 is due to shark bite experienced in some of the first generation of optical fibre cables. This problem has been alleviated by the introduction of specially shielded cable designs.

In this and most of the subsequent figures, the fault data has been normalized by the number of kilometres of cable currently installed in depths less than 1000 metres, since most faults caused by human activity occur in this depth range. In Figure 1, the same normalization has been used for the natural fault data, even though such faults occur at all depths, in order to allow direct comparison of the curves.

The aggression by human activity can conveniently be divided into three categories:

- trawling and other net fishing;

- shellfishing on the seabed;

- anchoring.

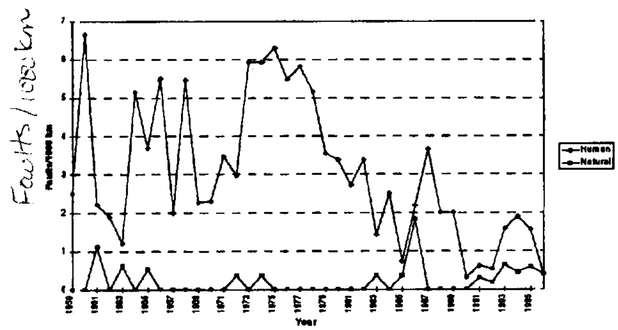

Figure 1: Aggression faults normalized to cable length in < 1 km depth

2.1 TRAWLING AND OTHER NET FISHING

The history of faults due to trawling and similar fishing activity is shown in Figure 2, separately for coaxial and fibre systems. The average fault rate for coaxial systems was approximately constant at about 3.7 faults per 1000 km per year from 1959 to 1979. The sharp decrease in the 1980 to 1985 period was due to the widespread burial of previously installed and new cable systems in fishing grounds. After 1985, the average fault rate was about 0.44 faults per 1000 km per year. This clearly demonstrates the benefit of cable burial in protecting the owners' investment.

1959-7
3.7/1000
1985
0.44/100

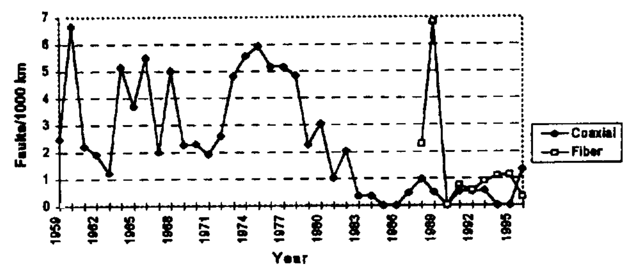

Figure 2: Trawler and other net fishing faults normalized by cable in < 1 km depth

The high number of faults in optical systems shown for 1988 and 1989 all occurred on TAT-8 in the eastern Atlantic, many in an area with shifting sand waves. Improvement in system burial resulted in the subsequent fault history of fibre systems being essentially the same as that of coaxial systems.

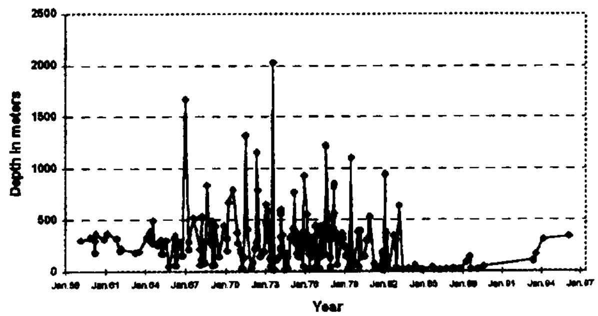

Figure 3: Trawler damage depth history, coaxial systems

An interesting history of the depth of trawler faults in coaxial systems is shown in Figure 3. Many faults occurred in depths less than 500 metres from 1967 until 1982, with a substantial number of faults in much deeper water. A review of the details of these faults reveals that most of them occurred on TAT-1 and TAT-2 in the heavily fished area of the Grand Banks off Canada. With the retirement of TAT-1 in 1978, the fault density decreases, and the faults nearly disappear with the retirement of TAT-2 in 1982. Data shows that deep-water fishing has been going on for many years in some areas, and emphasizes the importance of avoiding such areas where possible.

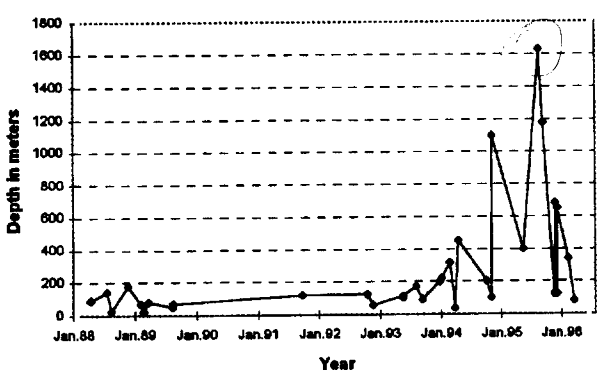

Figure 4: Recent trawler damage depth history, coaxial and fiber systems

After 1983, the curve has a very different character. Figure 4 shows the depth history of faults for both coaxial and fibre systems from 1988 to the present. Until 1994, fault depths were less than 200 metres. More recently, however, due to US and Canadian governmental fishing restrictions in shallower water in the western Atlantic, fishermen who have the necessary equipment have been working the deeper waters south of the Grand Banks and off the north eastern coast of the US. Cables have been damaged in depths close to the capability of today's towed plows. Such activity decreased in 1996, primarily due to the expense of deep-water fishing and the limited marketability of the species found. However, with improved equipment and with changing market tastes, deep-water fishing could readily increase in the future, resulting in more frequent attacks on unburied cables.

2.2 SHELLFISHING

Figure 5 shows fault data for sea-bottom shellfishing. Faults from this cause have occurred primarily in the western Atlantic, where such fishing is done over a wide area. The first aggression attributed to shellfishing happened in 1971, and such attacks continued for a number of years afterward. Even though the shellfishing equipment does not penetrate deeply into the seabed, the fishermen typically make repeated passes over the same area, so the total depth disturbed can be significant. In addition, equipment improved during this period and new species, notably quahog clams, became commercially marketable, resulting in expansion of the fishing grounds.

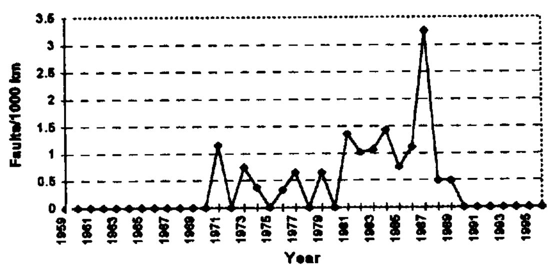

Figure 5: Shellfishing normalized to cable length in < 1 km depth

In response, more cable was buried, it was buried deeper, and some cables were rerouted from fishing grounds to unfishable, rocky areas. After a particularly bad experience in 1987, these measures were finally successful, and no faults have been reported from this cause in the Atlantic and Caribbean since 1990.

2.3 ANCHORING

Anchors are particularly damaging to cable systems because of their strength and because of the great depth to which they penetrate the bottom. Figure 6 presents total anchor fault experience for coaxial and fiber systems, and clearly shows a trend of increasing frequency of attack with time. It is also evident from this data that the extensive cable burial programs carried out in the early 1980s, which had a dramatic effect on trawler faults, had no effect on anchor attack. This is believed to be due to the fact that anchors can penetrate the seabed more effectively than towed cable plows.

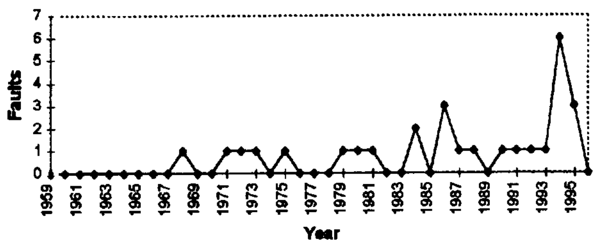

Figure 6: Anchor faults, coaxial and fiber systems

2.4 FAULT SOURCE SUMMARY

Statistical data shown in the previous sections indicates that human action is responsible for more than 90% of external agression faults and the specific nature of these is discussed in the following sections. The discussion relates largely to information gathered in relation to the North Atlantic but is generally applicable worldwide.

3. THE THREAT FROM FISHING

The overall threat from fishing activity derives from a combination of the seabed penetration of each method, the power of the vessels involved and the areas over which they operate. Of the methods currently in use, trawling is considered the greatest threat to cables, although bottom set fixed fishing gear and dredges also pose a significant risk. This section briefly outlines various fishing methods with particular emphasis on the extent to which they may interfere with cables by penetration of the gear. Also discussed are the areas of operation for each method and how these are changing.

Whilst cable burial to a target depth of 0.6 to 1 metre into the seabed in water depths down to 1000 metres has resulted in a substantial reduction in the number of fishing related cable incidents on new systems, the increasing demand for fish and shellfish throughout the world shows that fishing methods capable of damaging cable are spreading to deeper waters as more traditional fisheries decline and new resources are exploited.

3.1 TRAWLING

Trawling is the most widespread form of fishing, utilising by far the largest number of vessels and covering a larger area of the seabed per trip than any other method. Furthermore, it utilises the most powerful vessels, and with modern trawlers generating a towing force of around 130 kN per 1000 kW of vessel power it is not surprising that bottom trawling is the most commonly reported cause of fishing-related cable damage. Demersal otter trawling probably constitutes the biggest single risk group to cable. However, other forms of trawling also pose a threat including, beam trawling and twin trawling but it should be appreciated that fishermen aim to operate their equipment on or above the seabed, not below it. A brief description of the various forms of trawling is provided, based on European methodologies. It should be appreciated however that equipment, procedures, fishing depths and regulations do vary with geographic location.

The otter trawl consists of a wide net, held open by a pair of otter boards or doors, and towed along the seabed at speeds of up to 4.0 knots, by vessels ranging in power from 100 kW to 3000 kW. Contact of the catching net with the seabed is maintained by a variety of chains and ground gear. The main threat this arrangement poses to cables is impact and entanglement with either of the otter boards. The chances of this occurring are increased if the boards are damaged or badly maintained or if additional weights are added to the shoe plate.

Although otter boards can weigh up to 3500 kg, they are designed to skim the surface of the seabed and in normal circumstances would not be expected to penetrate by more than 50 mm. Nevertheless, evidence from board wear does suggest that in very soft ground they can penetrate up to 300mm. However, such penetration results in increased tow tensions and consequently is to be avoided to prevent sediment entering the trawl, and, given that good burial is achieved in such ground, the risk lies largely in areas where cable burial is unreliable or unachievable. Only a minimal risk reduction is achieved by additional cable armouring at or near the surface in regions where powerful vessels are operating.

Beam trawling utilises two identical beam trawls towed over the seabed at speeds of up to 6 knots from port and starboard derrick booms, at depths generally less than 100 metres. The mouth of each trawl net is held open by a heavy tubular beam supported at its ends by triangular shaped shoes. There are approximately 750 vessels in the European Atlantic Fishery, which range in power from 150 to 1900 kW. Beam trawling is closely regulated by the European Union fisheries policy which includes placing a limit of 12 metres on the maximum permissible beam width. The main threat to cables is impact from the base of the shoes and possible entanglement with the ancillary gear. Beam trawling has been responsible for many cable faults and much of the current fault data in the North Sea relates to surface laid cables being hooked by unmodified trawls. The risk of hooking cable has been reduced in recent years by modifying the shoes to fit fenders or rounded fronts to the leading edges.

Beam trawling constitutes a lower risk than otter trawling. The worst case estimate for beam trawl penetration is quoted as 150 mm and the threat is further reduced by the tendency of the front edge of the trawl shoes to lift off the bottom, when towed at speed.

Whilst beam trawling may be diminishing as a threat, there may be an increasing threat in the form of twin trawling. This consists of two identical trawls towed by a single vessel on two or three warps. The trawl mouth opening is achieved by otter boards on the outer wings and a heavy clump weight or sled linking the inner wings. The method is primarily targeted at shrimp. New, heavier trawls, are being used to target hake in arctic and sub-arctic regions. These trawls have also been found suitable for other bottom feeding fish and can therefore be reasonably expected to become more widely used in the future.

Twin trawling is on the increase, but as yet no precise information is available on the intrusion this makes into the seabed. The opinion is that the outer otter boards are probably subject to the same 300 mm maximum as single trawling. The greater concern arises from recent developments where the triangular centre clump weight, which, although fitted with bottom rollers, may weigh up to 7 tonnes and thus be prone to sinkage in soft grounds.

3.2 DREDGES

Dredging is the generic term describing a number of towed fishing gears which are designed to dig into the sediments to harvest shellfish in water depths down to 100 metres. They may be of the so-called 'dry' type which consist of a rectangular frame with a toothed bar on the leading edge, combined with a netting bag or of the mechanised hydraulic or 'wet' dredge type, which fluidises the seabed ahead of the dredge and pumps the slurry through a separating device to recover marketable shellfish.

There have been a number of faults in surface laid cable attributed to this type of fishing activity, especially clam dredging, off the east coast of the US.

'Dry' dredges are designed to disturb the substrate to a depth of about 150 mm. In 'wet' dredges, penetration of the scraper blade is about 200 mm, but the liquefaction process can extend down to about 300 mm. The worst case situation relates to Quahog dredging where the equipment may penetrate the seabed to a depth of 450 mm. The threat is further increased from repeated dredging operations over the same ground that may erode the seabed to the extent that cables initially buried to 0.6 metres become exposed.

3.3 BOTTOM SET FIXED FISHING

These are passive fishing methods in which gear is anchored to the seabed to catch fish during their feeding or migratory movements. They include longlines, vertical lines, bottom set nets including stow nets and traps or pots. There are two threats to cables from this type of fishing as follows:

- damage from fishing gear anchors;

- damage to lightweight cables from fishing hooks.

The largest fishing anchors identified in a recent North Atlantic survey, were 85 kg with a maximum fluke length of 800 mm, although most ranged from 25 to 50 kg. A limiting factor on the damage they can inflict is set by the breaking strength of the anchor wire, typically around 50 kN.

The notable exception is stow (or fyke) net fishing largely carried out in Korean waters, where the use of heavy anchors in soft ground is a proven hazard to cables. The gear consists of a conical net up to 100 metres in length in which the mouth is held open by a tubular framework. They may have netting wings to shepherd the fish into the mouth. The stow net depends on a strong and persistent current along which the fish make a daily migration. The net may be attended by a vessel, which as well as hauling the daily catch, can raise or lower the net into the path of migratory fish. The net is held in position by anchors weighing up to 1500 kg that will also hold the vessel in position.

Penetration from the majority of anchors used in fixed net fishing is likely to be small. The maximum penetration of these anchors would be about 1.1 times the fluke length and the threat is further reduced by the common practice of using anchors that allow easy recovery in the event of fouling. The exception is the practice of stow net fishing in shallow water where the largest anchors used may penetrate good ground by up to 1.5 metres, and soft ground by up to 2.7 metres, as measured by Travocean for Alcatel, following a power cable fault south of Korea attributed to stow net fishing. A key factor in the high risk they present is that the frequency of deployment and retrieval of stow net anchors is much higher than normal ship anchoring procedures.

3.4 LONGLINES

Although only a few cable faults have been attributed to longlines, these continue to pose a hazard, particularly during cable installation; lightweight cables being most at risk as the use of longlines is increasing in deep-water fisheries. The main line of a longline is laid horizontally on or just above the seabed and can extend up to 13 km and carry up to 8400 steel hooks. Vertical lines are similar to longlines except, as their name suggests, they are deployed vertically. The risks from this type of fishing are: where the size and design of the hook are such that it can penetrate deeply into the cable insulation; the use of mainline anchors, and, when grapnels are used to recover gear.

Deep water longlines tend to employ large anchors but fault statistics suggest that the threat from longlines tends to be from hooks rather than from anchors.

3.5 AREAS AND DEPTHS OF FISHING ACTIVITY

Otter trawling is practised widely over the continental shelf on both sides of the Atlantic. Since 1990 there has been an increase in the number of trawlers fishing the continental slopes down to 1700 metres, and more recently, the seamounts of the mid-Atlantic and Reykjanes ridge. Progression beyond 1700 metres cannot be ruled out, but the eventual biological limit is considered to be 2500 metres. The power of the vessels exploring deep water lies in the range 1000 to 3000 kW in order to handle the extra weight of long, high strength towing warps, heavy boards and mid-oceanic weather conditions.

Although the location of deep-water fisheries is ever-changing, the current situation on trawling for the north Atlantic, i.e. at water depths in excess of 500 metres, is shown in Figure 7, together with other forms of fishing activity considered a threat to cable.

Many hundreds of vessels are engaged in twin trawling over an arc extending around the Atlantic rim from Florida to Shetland. Most are less than 300 kW, but a developing threat to cables comes from an increasing number of larger vessels of up to 3000 kW, fishing depths down to 900 metres. The largest vessels are at present confined to the Flemish Cap area and East Greenland but successful exploitation of deep-water shrimp there could lead to expansion of fisheries in other parts of the North Atlantic.

Various passive methods of fishing are carried out all around the Atlantic rim and on the mid-Atlantic ridge. The areas considered to be at most risk from longlines and vertical lines are also shown on Figure 7, in depths down to 1700 metres, although some Antarctic longlines are currently being set to 2500 metres.

'Dry' dredging is widely used around the Atlantic rim, but only in depths down to about 100 metres. 'Wet' dredging is mainly confined to the east coast of the US down to 100 metres and some very shallow areas of the Dutch and British coasts.

Stow net fishing is confined at present to the Far East, particularly off the south and west coast of Korea, in water 20 to 60 metres deep.

4. ANCHOR THREATS

Anchors are used for a wide variety of tasks ranging from the positioning of fishing gear through to the mooring of large merchant ships and the permanent fixture of offshore platforms used in the oil industry. We have even encountered a fault caused by a meteorological buoy dragging its anchor, although such events are rare.

The threat to undersea cable from such diverse applications differs widely and is discussed in more detail in this section, with the emphasis again placed on seabed penetration. However, statistics do indicate that the threat from anchors diminishes sharply with water depth to around 150 metres, beyond which anchor faults are virtually unknown.

4.1 ANCHORS FOR USE WITH FISHING GEAR

There are various forms of fishing that involve anchoring gear to the bottom. These include longlines, vertical lines, bottom set nets, traps or pots and fish aggregation devices (FADS). The largest anchors for these applications are, however, less than 100 kg in weight,

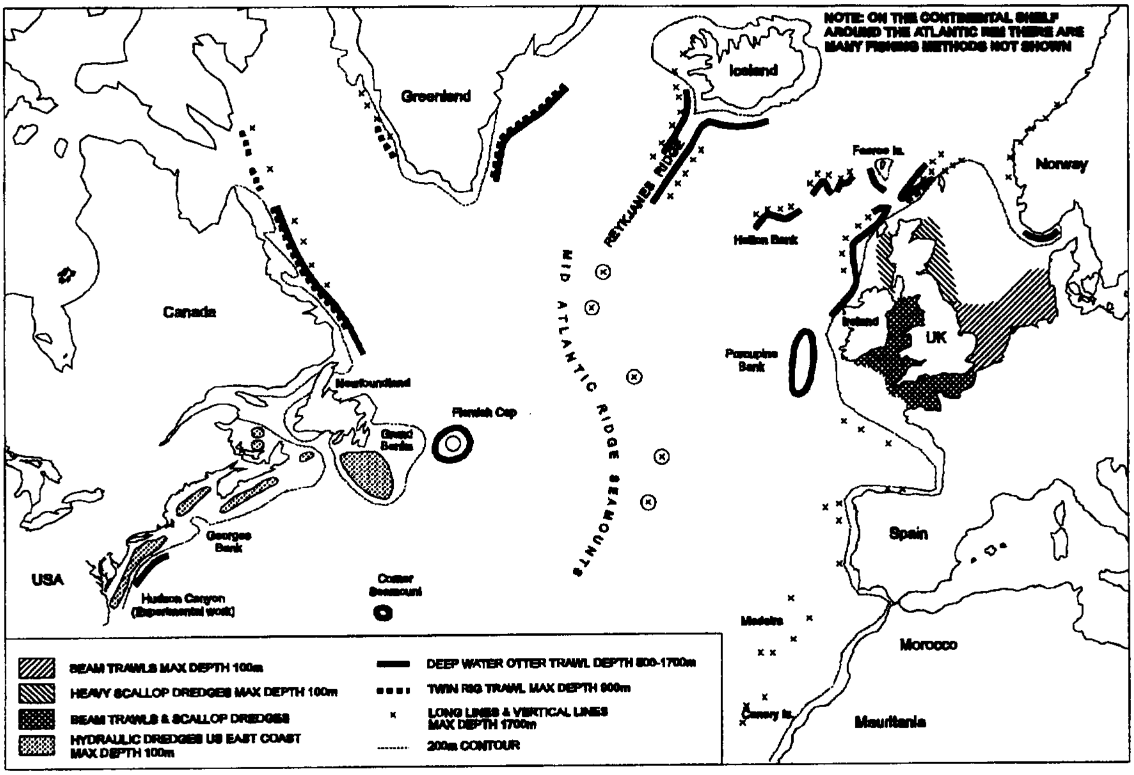

Figure 7: Fishing threat in the North Atlantic

and although capable of penetrating the seabed by up to 1 metre, would generally represent a low risk to a buried submarine cable. A notable exception is the practice in the Far East of stow net fishing in which anchors up to 1500 kg in weight and fluke lengths of 1.5 metres may be used. FADS are confined to tropical and sub-tropical waters in the Far East and Pacific.

4.2 PERMANENT MOORINGS

Anchors used with these structures are designed to produce very high holding power, without the normal constraints of ease of recovery and handling imposed by normal ships' use. These anchors have to be placed very carefully in position on the seabed and then remain in place for long periods. Extensive development has improved the performance of these anchors and whilst they may penetrate several metres into the seabed, they do so over short distances in pre-planned positions where their users should have a good awareness of cable installations. Unless the structure breaks free in extreme weather conditions, this type of anchor does not represent a major risk to submarine cables, and the fault statistics gathered to date support this.

4.3 SHIPS' ANCHORS

This class of anchor poses by far the greatest threat to cable. The world fleet, as described by its Gross Registered Tonnage (GRT) in Lloyds Register of Shipping, contains 83,000 vessels ranging from 100 GRT to 150,000+ GRT. An analysis of a sizeable sample from the register has been used to produce the relationship between gross tonnage of the vessel and the weight of its anchor.

In order to scope the overall threat of cable damage from ships' anchors it is necessary to examine more closely design features of anchors, their size distribution for various applications and how these affect penetration into the seabed. There is a vast selection of ships' anchors available but the majority of anchors on modern vessels are the bow (or bower) type, of which the "stockless" type shown in Figure 8 is the most common. The most modern large vessels now employ a high holding power variation of this design. These are popular because they allow a 25% weight concession by virtue of their increased efficiency, thus easing space and cost considerations. Examples of these are Stokes, Danforth and Admiralty Cast (AC) designs. The improved performance is achieved by greater penetration into the seabed.

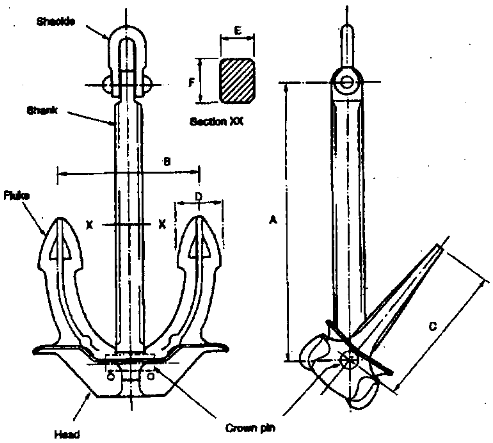

Figure 8: Stockless anchor details

The most important parameters to anchor users are holding power and the drag distance needed to realise full holding power. Direct measurements of the penetration into the seabed are therefore not often reported in the literature. However, a comprehensive study of anchor performance was carried out by NCEL (1) for the US Navy and this included penetration data for a group of drag anchors as shown in Figure 9. In addition, information from Lloyds Register on anchor size versus vessel size and dimensional details from anchor manufacturers allows the relationship between seabed penetration into firm ground and ships gross tonnage to be estimated (Figure 10).

Practical trials have demonstrated that maximum holding power is achieved with a fluke angle of 32^0 in gravel, whereas the optimum for soft mud is 50^0. Manufacturers often use 40^0 as a compromise for all types of seabed. A fluke angle of 40^0 will limit the vertical penetration in good ground, where the stock remains horizontal on the surface, to the fluke length x sin 40^0.

In general, ships anchor in good ground with anchor penetration in the region of one fluke length, equivalent to around 2.2 metres for the largest anchors. Of course, in the extreme circumstances of anchoring on a soft seabed, greater penetration is to be expected. Take, for example, a 5,000 GST vessel with a 4 tonne stockless anchor; the anchor would have a fluke length of about 1.6 metres, and from Figure 9 would be expected to penetrate into soft mud by 5 metres.

The risk of an anchor hooking a cable is not only related to its penetration, but also to the distance over which it disturbs the seabed. The initial drag distance required by an anchor to develop its full holding capacity is therefore

Anchor Type	Sands/ Stiff Clays	Mud/ Soft Silts/ Clay
Stockless	1	3
Moorfast Offdrill 2	1	4
Boss Danforth Flipper Delta GS Type 2 LWT Stato Stevfix* Stevpris*	1	4.5
Bruce* Bruce TS* Hook* Stevmud*	1	5

* anchors more appropriate to permanent moorings.

Figure 9: Fluke Tip Penetration in multiples of fluke length

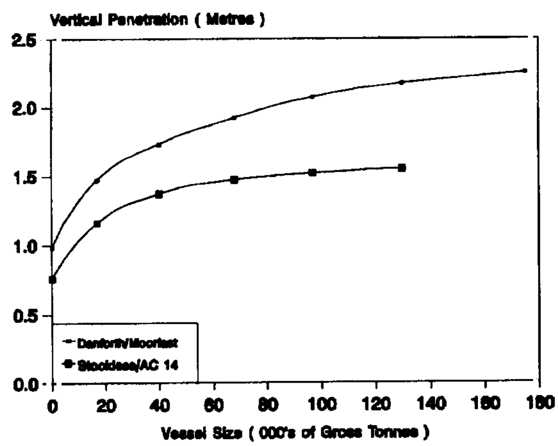

Figure 10: Anchor penetration versus vessel size for firm ground

an important parameter governing the risk to submarine cables. In this respect, many anchors are similar in taking 20 to 30 times the fluke length to reach 90% of their full pull-out strength. This means that the chance of hooking a cable increases with anchor size by virtue of both its penetration and its drag distance. Another factor in determining the risk, is the behaviour of an anchor when conditions exist to cause it to be dragged by a vessel. This will normally cause the anchor to break out by rotation, only for continued drag to cause it to re-penetrate. This situation obviously constitutes a high risk, should it continue over a long distance. Although there have been accounts in the past of this causing multiple faults on surface laid coaxial cables, it is not considered a common occurrence, considering the number and spacing of cable installations.

5. MINIMISING THE THREAT FROM FISHING AND ANCHORS

Past experience has shown that re-routing has been effective in eliminating the threat from shellfishing in the Western Atlantic but in order to further reduce the number of cable faults attributed to fishing in general, more consistent burial techniques are required to ensure that the cable remains below the threat line of 0.3 metres. Furthermore, burial should be extended to counteract the development of fishing in deeper waters, again adjusting the burial depth in accordance with the seabed penetration of fishing activity. Detailed studies of the intensity of shipping activity to determine the density of vessels and their size, will enable estimates to be made of the size and hence penetration depth distribution of their anchors. This process should lead to a recommendation for burial to a depth to place the cable substantially beneath the anchor threat line, perhaps as deep as 3 metres in particularly vulnerable areas, in water depths down to 150 metres. An example of a future burial line taking account of all perceived risks is shown in Figure 11. Where the depth profile of the route is such that extensive sections of cable lie within the 150 metre depth contour, this policy may be waived where the threat is considered negligible, for example where distance from the coastline means that anchoring is extremely unlikely.

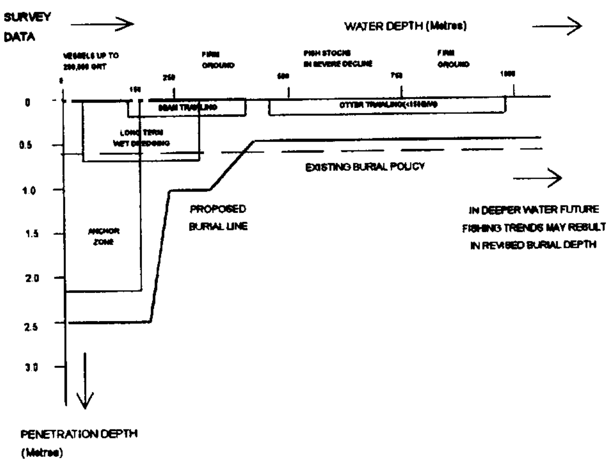

Figure 11: Example of concept of adusting burial depth to remain below threat line

Fault statistics suggest that the shortest route to 150 metres water depth will further reduce the risk of anchor faults. Avoidance of anchor zones, especially those which coincide with easily penetrable seabeds, will further reduce the incidence of such faults. Furthermore, developments in the use of satellite surveillance to determine the extent to which vessels observe anchoring zones may also provide useful information.

6. CONCLUSION

Analysis of the historical data indicates that the fault records of fibre and coaxial systems are similar and that whilst cable burial 0.6 to 1 metre below the seabed provides a very effective means of protecting cable against fishing activity, it is ineffective against anchors in soft sediment.

Fishing is moving deeper, beyond the range of the present towed ploughs and this trend is likely to continue because of the conservation of shallow-water species. Otter and twin trawling in particular represent a developing threat in slope areas and around sea mounts down to 1700 metres at the present time, although these may extend even deeper. Of the remaining fishing activities, stow net anchors, mechanised hydraulic dredges and longline hooks remain as additional significant threats.

After reviewing all types of anchors it is concluded that ships' anchors represent by far the highest threat to cable. Studies of the size distribution of the world fleet, anchor designs and seabed penetration indicate that anchors capable of exceeding current cable burial depths are quite common.

In order to minimise the threat from fishing and anchors for future systems, a contract-specific burial policy is required that places cable below the perceived threat line. Establishing this threat line will require greater attention to survey data and a more detailed knowledge of local fishing and shipping activities. However, the additional costs involved should be more than covered by the improvement in system security.

7. ACKNOWLEDGEMENT

The authors would like to thank their colleagues in CWM and KDD-SCS for the discussions and contributions towards compiling this paper.

8. REFERENCES

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Appendix E

Fish Species of Massachusetts Bay

Table E-1. Fishes of Massachusetts Bay (Collette and Hartel, 1988)

Myxinidae (hagfishes)	*Myxine glutinosa* (Atlantic hagfish)
Petromyzonitdae (lampreys)	*Petromyzon marinus* (sea lamprey)
Odontaspididae (sand sharks)	*Eugomphodus taurus* (sand tiger)
Alopiidae (thresher sharks)	*Alopias vulpinus* (thresher shark)
Lamnidae (mackeral sharks) *Carcharodon carcharias* (white shark) *Cetorhinus maximus* (basking shark) *Isurus oxyrinchus* (shortfin mako) *Lamna nasus* (porbeagle)	
Carcharhinidae (requiem sharks) *Mustelus canis* (smooth dogfish) *Proinace glauca* (blue shark)	
Sphyrinidae (hammerhead sharks) *Sphyrna tiburo* (bonnet head) *Sphyrna zygeana* (smooth hammerhead)	
Squalidae (spiny dogfish) *Squalus acanthias* (spiny dogfish) *Somniosus microcephalus* (greenland shark) *Squatina dumeril* (Atlantic angel shark)	
Torpedinidae (torpedo or electric rays) *Torpedo nobiliana* (Atlantic torpedo)	
Rajidae (skates) *Raja erinacea* (little skate) *Raja ocellata* (winter skate) *Raja laevis* (barndoor skate) *Raja radiata* (thorny skate) *Raja senta* (smooth skate)	
Acipenseridea (Sturgeons) *Acipenser brevirostrum* (shortnose sturgeon) *Acipenser oxyrhynchus oxyrhinchus* (Atlantic sturgen)	
Anguillidae (freshwater eels) *Anguilla rostrata* (American eel) *Conger oceanicus* (Conger eel)	
Clupeidae (herrings) *Alosa aestivalis* (blueback herring) *Alosa pseudoharengus* (alewife) *Alosa sapidissima* (American shad) *Brevoortia tyrannus* (Atlantic menhaden) *Clupea harengus harengus* (Atlantic herring)	
Engraulidae (anchovies) *Anchoa michilli* (bay anchovy) *Engraulis eurystole* (silver anchovy)	

Table E-1 (continued). Fishes of Massachusetts Bay (Collette and Hartel, 1988)

Osmeridae (smelts) *Osmerus mordax* (rainbow smelt)
Salmonidae (salmons) *Oncorhynchus kisutch* (coho salmon) *Salvelinus fontinalis* (brook trout) *Salmo salar* (Atlantic salmon)
Sternoptychidae (hatchet fishes) *Maurolicus muelleri* (pearlsides)
Batrachoididae (toadfishes) *Opsanus tau* (oyster toadfish)
Lophiidae (goosefishes) *Lophius americanus* (American goosefish)
Merlucciidae (silver hake) *Merluccius bilinearis* (silver hake)
Gadidae (cod) *Brosme brosme* (cusk) *Enchelyopus cimbrius* (fourbeard rockling) *Gadus morhua* (Atlantic cod) *Melanogrammus aeglefinus* (haddock) *Microgadus tomcod* (Atlantic tomcod) *Pollachius virens* (pollock) *Urophycis chuss* (red hake) *Urophycis tenuis* (white hake)
Macrouridae (grenadiers) *Nezumia bairdii* (marlin-spike)
Zoarcidae (eel pouts) *Lycenchelys verrillii* (wolf ellpout) *Macrozoarces americanus* (ocean pout)
Hemiramphidae (halfbeaks) *Hyporhamphus unigasciatus* (halfbeak)
Scomberesocidae (sauries) *Scomberesox saurus* (Atlantic saury)
Cyprinodontidae (killifishes) *Fundulus heteroclitus macrolepidotus* (mummichog) *Fundulus mafalis* (striped killifish)
Atherinidae (silversides) *Menidia beryllina* (inland silverside) *Menidia menidia* (Atlantic silverside)
Zaidae (John dories) *Zenopsis conchifera* (buckler dory)

Table E-1 (continued). Fishes of Massachusetts Bay (Collette and Hartel, 1988)

Gasterosteidae (sticklebacks) *Apeltes quadracus* (fourspine stickleback) *Gasterosteus aculeatus* (threespine stickleback) *Gasterosteus wheatlandi* (blackspotted stickleback)
Fistulariidae (cornetfishes) *Fistularia tabacaria* (bluespotted cornetfish)
Syngnathidae (pipefishes) *Hippocampus erectus* (lined seahorse) *Syngnathus fuscus* (northern pipefish)
Mornonidae (temperate basses) *Morone americana* (white perch) *Morone saxatilis* (striped bass)
Serranidae (sea basses) *Centropristis striata* (black sea bass)
Priacanthidae (bigeyes) *Pristigenys alta* (short bigeye)
Pomatomidae (bluefish) *Pomatomus saltatrix* (bluefish)
Echeneidae (remoras) *Echeneis naucrates* (sharksucker) *Remora brachyptera* (spearfish remora) *Remora remora* (remora)
Ariummidae (driftfishes) *Ariumma bondi* (silver rag)
Centrolophidae (rudderfishes) *Hyperoglyphe perciformis* (barrelfish)
Stromatidae (butterfishes) *Peprilus triacanthus (butterfish)*
Carangidae (jacks) *Caranx crysos* (blue runner) *Caranx hippos* (crevalle jack) *Naucrates ductor* (pilotfish) *Selar crumenophthalmus* (bigeye scad) *Selene setapinnis* (Atlantic moonfish) *Selene vomer* (lookdown) *Seriola zonata* (banded rudderfish) *Trachurus lathami* (rough scad)
Sparidae (porgies) *Stenotomus chrysops* (scup)

Table E-1 (continued). Fishes of Massachusetts Bay (Collette and Hartel, 1988)

Sciaenidae (drums and croakers) *Cynoscion regalis* (weakfish) *Leiostomus xanthurus* (spot) *Menticirrhus saxatilis* (northern kingfish) *Pogonias cromis* (black drum)
Labridae (wrasses) *Tautoga onitis* (tautog) *Tautogolabrus adspersus* (cunner)
Mugilidae (mullets) *Mugil cephalus* (striped mullet)
Stichaeidae (pricklebacks) *Lumpenus lampretaeformis* (snake blenny) *Lumpenus maculatus* (daubed shanny) *Stichaeus punctatus* (arctic shanny) *Ulvaria subbifurcata* (radiated shanny)
Pholidae (gunnels) *Pholis gunnellus* (rock gunnel)
Anarhichadidiae (wolffishes) *Anarhichas lupus* (Atlantic wolffish) *Anarhichas minor* (spotted wolffish)
Cryptacanthodidae (wrymouths) *Cryptacanthodes maculatus* (wrymouth)
Ammondytidae (sand lances) *Ammodytes americanus* (American sand lance) *Ammodytes dubius* (northern sand lance)
Trichiuridae (cutlassfishes) *Trichiurus lepturus* (Atlantic cutlassfish)
Scombridae (mackerels) *Sarda sarda* (Atlantic bonito) *Scomber japonicus* (chub mackerel) *Scomber scombrus* (Atlantic mackerel) *Scomberomotus maculatus* (Spanish mackerel) *Thunnus thynnus* (Atlantic bluefin tuna)
Xiphiidae (swordfish) *Xiphias gladius* (swordfish)
Scorpaenidae (rockfishes) *Sebastes fasciatus* (Acadian redfish)
Reglidae (searobins) *Prionotus carolinus* (northern searobin) *Prionotus evolans* (striped searobin)

Table E-1 (continued). Fishes of Massachusetts Bay (Collette and Hartel, 1988)

Cottidae (sculpins) *Artediellus atlanticus* (atlantic hookear sculpin) *Hemitripterus americanus* (sea raven) *Myoxocephalus aenaeus* (grubby) *Myoxocephalus octodecemspinosus* (longhorn sculpin) *Myoxocephalus scorpius* (shorthorn sculpin) *Triglops murrayi* (moustache sculpin)
Agonidae (alligatorfishes and poachers) *Aspidophoroides monopterygius* (alligatorfish)
Cyclopteridae (lumpfishes and snailfishes) *Cyclopterus lumpus* (lumpfish) *Eumicrotremus spinosus* (Atlantic spiny lumpsucker) *Liparis atlanticus* (seasnail) *Liparis coheni* (gulf snailfish)
Dactylopteridae (flying gurnards) *Dactylopterus volitans* (flying gurnard)
Bothidae (lefteye flounders) *Paralichthys* oblongus (fourspot flounder) *Scophthalmus* aquosus (windowpane) *Etropus microstomus* (smallmouth flounder)
Pleuronectidae (righteye flounders) *Glyptocephalus cynoglossus* (witch flounder) *Hippoglossoides platessoides* (American plaice) *Hippoglossoides hippoglossus* (Atlantic halibut) *Limanda ferruginea* (yellowtail flounder) *Liopsetta putnami* (smooth flounder) *Pseudopleuronectes americanus* (winter flounder)
Soleidae (soles) *Trinectes maculatus* (hogchoker) *Balistes capriscus* (gray triggerfish)
Monacanthidae (filefishes) *Monacanthus hispidus* (planehead filefish) *Aluterus schoepfi* (organe filefish)
Tetraodontidae (puffers) *Sphoeroides maculatus* (northern puffer)
Diodontidae (porcupine-fishes) *Chilomycterus schoepfi* (striped burrfish)
Molidae (ocean sunfishes) *Mola mola* (ocean sunfish) *Mola lanceolata* (sharptail mola)

Source: Collette and Hartel, 1988, cited in Earth Tech 1999.

Appendix F

Marine Bird Species Occurring in the Southwestern Gulf of Maine and Likely in Stellwagen Bank National Marine Sanctuary

Table F-1: Groups of Marine Bird Species Occurring in the Southwestern Gulf of Maine and Likely in Stellwagen Bank National Marine Sanctuary (NOAA 1993, cited in Earth Tech 1999)

Group	Scientific/Common Name
Albatross	*Diomedea spp.*
Alcids	*Alca torda/*Razorbill
	*Cepphus grylle/*Black guillemot
	*Fratercula arctica/*Atlantic (Common) puffin
	*Plautus alle alle/*Dovekie
	*Uria lomvia/*Thick-billed (Brunnich's) murre
	*U. aalge/*Thin-billed (common) murre
Ducks	*Melanitta deelandi*/White-winged scoter
	Negri/Black scoter
	*Perspicillata/*Surf scoter
	*Somateria mollisima/*Red-Breasted merganser
	Clangula hyemalis/Oldsquaw
Fulmars	*Fulmarus glacialis/*Northern Fulmar
Gannets/Cormorants	*Phalacrocorax auritus/*Double-crested cormorant
	*P. carbo/*Great cormorant
	*Sula bassanus/*Northern Gannet
Gulls/Jaegers/Skuas	*Catharacta skua/Great skua*
	*C. maccormickii/*South polar skua
	*Larus argentatus/*Herring gull
	*L. atricilla/*Laughing gull
	*L. delawarensis/*Ring-billed gull
	*L. glaucoides/*Iceland gull
	*L. marinus/*Great Black-backed gull
	*L. philadelphia/*Bonaparte's gull
	*L. hyperboreus/*Glacuous gull
	*Rissa tridactyla/*Black-legged kittiwake
	*Stercorarius longicaudus/*Long-tailed jaeger
	*S. parasiticus/*Parasitic jaeger
	*S. pomarinus/*Pomarine jaeger
	*Xema sabini/*Sabine's gull
Loons	*Gavis stellata/*Red-throated Loon
	*G. immer/*Common Loon
Phalaropes	*Phalaropus lobatus/*Red-necked (Northern) phalarope
	*P. fulicaria/*Red phalarope
Shearwaters	*Calonectris diomedea/*Corey's Shearwater
	*Puffinus griseus/*Sooty Shearwater
	*P. puffinus/*Manx Shearwater
	*P. gravis/*Greater Shearwater
Storm petrels	*Oceanites oceanicus/*Wilson's storm petrel
	*Oceanodroma leucorhoa/*Leach's storm petrel

Table F-1 (continued): Groups of Marine Bird Species Occurring in the Southwestern Gulf of Maine and Likely in Stellwagen Bank National Marine Sanctuary (NOAA 1993, cited in Earth Tech 1999)

Group	Scientific/Common Name
Terns	*Childonias niger*/Black tern
	Sterna albifrons/Least tern
	S. anaethetus/Bridled tern
	S. dougalii/Roseate tern
	S. fuscata/Sooty tern
	S. maxima/Royal tern
	S. paradisaea/Arctic tern
	S. sandivicensis/Sandwich tern
	S. hirundo/Common tern

Source: NOAA 1993, cited in Earth Tech 1999.